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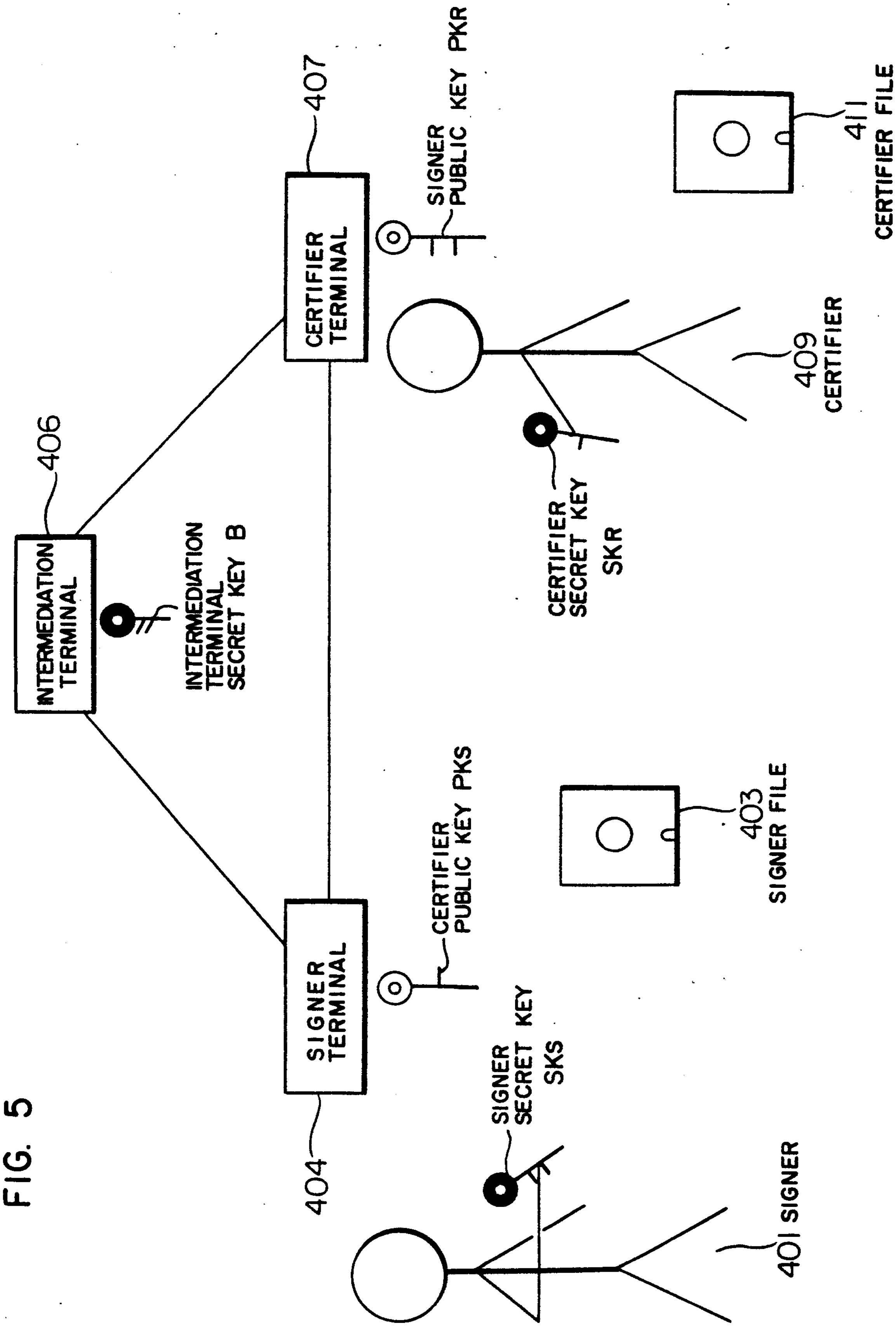
(54) Electronic transaction system.

(57) An electronic transaction in which in order to improve a reliability of message certification by digital signature and enable the use of the digital signature in a formal transaction in place of conventional signature or seal, the following procedures are implemented utilizing the fact that, in a public key cryptograph system represented by an RSA system, a first encoded message derived by encoding a first decoded message by using a public key of a first transacting party is equal to a second encoded message derived by encoding a second decoded message by using a public key of a second transacting party: a) Check sender/receiver; b) Add content certification function c) Double check the person by the possession of a secret key and the response by a terminal; d) Add a time limit to an effective period of an electronic seal; e) Add a grace period to the electronic seal; and f) Send back a tally impression from the receiver to the sender.

EP 0 214 609 A2

FIG. 5


406
INTERMEDIATION TERMINAL
INTERMEDIATION TERMINAL SECRET KEY B
407
CERTIFIER TERMINAL
SIGNER PUBLIC KEY PKR
411
CERTIFIER FILE
409
CERTIFIER
CERTIFIER SECRET KEY SKR
404
SIGNER TERMINAL
CERTIFIER PUBLIC KEY PKS
403
SIGNER FILE
SIGNER SECRET KEY SKS
401 SIGNER

ELECTRONIC TRANSACTION SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to an electronic transaction and more particularly to an electronic transaction system which electronically effects commercial transactions by computer documents instead of conventional documents.

In the past, contracts are authenticated or validated by signatures or seals. Where data are transmitted through a communication like electronic transaction between two parties having interests to each other, even if the signature and seal data are converted to digital signals for transmission, they may be easily copied and hence they cannot be used for authenticity. Accordingly, the authenticity of the message by digital signature which corresponds to the normal signature and seal is required. In order for the message authenticity to be effective as formal transaction in place of the signature or seal, the following four conditions should be met.

(a) Only the transmitter can prepare a signed message such as a contract. It cannot be forged by a third person.

(b) The receiver cannot alter the signed message.

(c) The transmitter cannot later deny the fact of transmission.

(d) The receiver cannot later deny the fact of reception.

The following methods have been proposed to achieve the digital signature.

(1) Digital signature which uses conventional cryptograph

(2) Digital signature which uses public key cryptograph

(3) Digital signature by hybrid system

Characteristics and problems of those three methods are described below.

(1) Digital signature which uses conventional crystograph

Many digital signature methods which use the DES (data encryption standard) system cryptograph have been proposed but notarization is required or the receiver can alter the signed message because the transmitting station and the receiving station have a common authenticity key. Accordingly, no practical signature system has been known.

(2) Digital signature which uses public key cryptograph

The digital signature can be relatively easily attained by using the public key cryptograph system represented by an RSA (Rivest-Shamir-Aldleman) algorithm.

Fig. 1 shows a chart of a prior art digital signature by the public key cryptograph.

In a step 101, a message M from a sender A is inputted.

In a step 102, a decoded message D (M, SK_A) is produced by decoding (deciphering) the message M by a secret key SK_A of the sender A.

In a step 103, the decoded message D (M, SK_A) is further encoded (enciphered) by a public key PK_B of a receiver B to produce a cryptograph message L = E (D (M, SK_A), PK_B), which is sent to the receiver B.

In a step 104, the data L is received by the receiver B is decoded by the secret key SK_B of the receiver B to produce D (M, SK_A).

In a step 105, the decoded message D (M, SK_A) is endoded by the public key PK_A of the sender A to produce the original message M.

In a step 106, the message M is supplied to the receiver B as an output data.

In the present flow chart, the cryptograph message M cannot be decoded in the step 104 unless the secret key SK_B is known. Only the receiver B knows SK_B. In the step 102; only the sender A who knows the secret key SK_A can produce D (M, SK_A). Accordingly, it is assumed that it is A that has sent the message M and it is B that has received the message.

When the message M is not a conventional sentence but random data, it is difficult to determine whether M is proper or not. As an approach thereto, an identifier of the sender, and identifier of the receiver, a serial number of the message and a date may be sent together with the message. In this case, an unauthorized act such as copying the signed message for repetitive transmission is prevented.

However, in the RSA system, the encoding and decoding time is long because of complex operation and a time-consuming problem will arise when the message is long.

(3) Digital signature by hybrid system

This system utilizes the advantages of the DES cryptograph system and the RSA cryptograph system in a well-mixed manner.

In this system, the conventional (ordinary) message is sent by the DES cryptograph communication and the transmission of the key and the authenticity utilize the RSA system. The message to be authenticated (validated) is first compression-decoded by the DES system to determine Hash Total. Fig. 2A shows a process therefor. In Fig. 2-(a), the following steps are carried out.

Step 1:

First 64 bits of an input message I are defined as I_1. The I_1 is encoded by an encoder 21 by using a cryptograph key K. The encoded result is defined as O_1.

$E_k(I_1) \rightarrow O_1$

The 64 bits of an input message subsequent to first 64(i-1) bits are defined as I_i.

Step 2:

Next 64 bits of the input message which follow to I_i are defined as I_{i+1}. An exclusive OR circuit 22 exclusively ORs I_{i+1} and O_i and an output thereof is encoded by the encoder 21 by using the key K.

$E_k(I_{i+1} + O_i) \rightarrow O_{i+1}$

Step 3:

If i < n-1, i is incremented by one and the process returns to the step 2. If not i < n-1, $O_{i+1} = O_n$ is outputted and the process is terminated. The RSA system digital signature is made only to the data having the finally produced cryptograph block (Hash total) O_n and data information added thereto.

In this system, even the digital signature to the long message can be processed in a short time.

The above systems do not meet the above-mentioned condition (c) of the digital signature, that is, "the sender cannot later deny the fact of transmission". In the system which uses either the conventional cryptograph or the public key cryptograph, if the sender falsely insists that the secret key has been stolen and someone has prepared data without authorization, it is difficult to determine whether it is true or not.

If the secret key has been actually stolen, it turns out that all messages signed before are uncreditable. Accordingly, in the digital signature, there is a severe requirement that the secret key must be absolutely protected.

As described above, the condition (c) is not met so long as the signatures are made by only the two persons, the sender and the receiver.

It has been proposed to meet the condition (c) by communicating through a reliable authentication (notary) organization. Fig. 3 illustrates a principle thereof.

In Fig. 3, a sender 34 sends a data consisting of message and signature to an authentication organization 31. The authentication organization 31 adds date information to the received data 35 to prepare data 32, which is sent to a receiver 33 and also recorded in a log 37. The sender 34 cannot later deny his message because the record is logged in the log 37 of the authentication organization 31. In this case, the sender may insist that the secret key has been stolen and someone has forged the message. Such insistence can be prevented by sending the same data 36 as the data 32 back to the sender 34 for confirmation.

Other problems are who the authentication organization should be and a large volume of message to be recorded.

As a modification of (3), a method for determining a Hash total by data compression encoding by DES in the hybrid digital signature is explained with reference to Fig. 4.

In Fig. 4, the following steps are carried out.

Step 210:

An input message M is divided into n 56-bit blocks M1, M2, ••• Mn

M = M1, M2, ••• Mn

Step 202:

A parity bit is added to every seven bits of Mi - (i = i, 2, ••• n) to produce Ki (i = 1, 2, ••• n).

Step 203:

The following step is repeated for j = 1, 2, ••• n.

I(j-1) is encoded by using Kj as a cryptograph key, and the encoded result and I(j-1) are exclusively ORed to produce I(j).

$I(j) \leftarrow I(j-1) \oplus EKj\,(I(j-1))$

where I(o) is an initial value.

Step 204:

$H(M) = I(n)$

Digital signature by the RSA system is made to the resulting cryptograph block compression encoded message H(M).

Referring to Fig. 2B, a method of digital signature by the hybrid system is explained.

A sender 301 calculates a short character string H(M) from a message M 302 by the data compression encoding, produces a digital signature E (H(M) , S_k) 306 by an encoder 305 by using a secret key S_k 304 and sends it to a receiver 307. In order for the receiver 307 to recognize that the message 302 and the digital signature 306 are true and valid, the receiver 307 decodes the digital signature E (H(M) , S_k) 306 by a decoder 309 to produce the original character string H(M) ' 310, and calculates a character string H(M) " 311 from the message 302 in the same manner as the sender 301 did. Both are compared by a comparator 312 and if they are equal, the message 302 is true and valid so long as the receiver believes that the sender 301 is a sole owner of the secret key S_k 304.

In this method, the digital signature to a long message can be processed in a short time, but this method does not meet the condition (d) (the receiver cannot later deny the fact of reception). If the receiver later denies the fact of reception, the sender has no evidence to deny it.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an electronic transaction which eliminates the disadvantages in the digital signature encountered in the prior art system, realizes a function of an authentication organization, reduces the quantity of message to be recorded concerning such as the content of a contract and meets the following conditions.

(1) Only a sender can prepare a signed message. It cannot be forged by a third party.

(2) A receiver cannot alter the signed message.

(3) The sender and receiver cannot later deny the facts of transmission and reception, respectively.

In order to achieve the above object, one feature of the present invention includes the following steps.

① Sender and receiver are checked.

② Content certificate function is added.

③ The sender or receiver is double-checked by the possession of a secret key and a terminal response.

④ A time limit to an effective period for an electronic seal is set.

⑤ A grace period is added to the electronic seal.

⑥ A tally impression is sent from the receiver back to the sender.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flow chart of a prior art digital signature procedure which uses a public key cryptograph system,

Figs. 2A, 2B and 4 show principles of known data compression cryptograph,

Fig. 3 shows a prior art digital signature system which uses an authentication organization,

Fig. 5 shows a first system configuration of an electronic transaction system to which the present invention is applied,

Fig. 6 shows a flow chart of a procedure in a first embodiment of the present invention,

Fig. 7 shows a flow chart of a procedure in a second embodiment of the present invention,

Fig. 8 shows a flow chart of a procedure in a third embodiment of the present invention,

Fig. 9 shows a second system configuration of the electronic transaction system to which the present invention is applied,

Fig. 10 shows a flow chart of a procedure of a fourth embodiment of the present invention,

Fig. 11 shows a third system configuration of the electronic transaction system to which the present invention is applied, and

Fig. 12 shows a flow chart of a procedure in a fifth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to facilitate the understanding of the present invention, the contents of the above items ①~⑤ are explained in detail.

① Confirmation of sender and receiver

In the following description, the sender of the transaction message is referred to as a signer and the receiver is referred to as a certifier.

Two sets of public key and secret key in the public key cryptograph system are prepared. They are (public key, secret key) : (PK_S, SK_S) and (PK_R, SK_R), where SK_S is owned only by the signer and SK_R is owned only by the certifier, and PK_S and PK_R are copied to all concerned.

Assuming that a message M consists of m binary bits, the following is met in the public key cryptograph system.

$M = E\ (D(M,\ SK_S),\ PK_S$

$= E\ (D(M,\ SK_R\ ,\ PK_R\ .....\ (1)$

where D (*, K) is a message decoded from a message * by a key K, and E (*, K) is a cryptograph encoded from the message * by the key K. The same message is supplied to the signer and the certifier, who decode it by their own secret keys and the decoded results D (M, SK_S) and D (M, SK_R) are disclosed to the persons concerned, who encode D (M, SK_S) and D (M, SK_R) by using the signer's and certifier's public keys PK_S and PK_R which the persons concerned possess. The persons concerned can confirm that the formula (1) is met if the signer and the certifier properly used their secret keys. If the formula (1) is not met, the persons concerned may determine that the secret key of the signer or the certifier is not valid.

For example, if the signer forges the signed message by using a false secret key $SK_S'(\neq SK_S)$,

$E\ (D(M,\ SK_S')\ PK_S) \neq E\ (D(M,\ SK_S)\ ,\ PK_S)$

$E\ (D(M,\ SK_S')\ PK_S \neq E\ (D(M,\ SK_R)\ ,\ PK_R)\ .....(2)$

Thus, the persons concerned may determine that the secret key used by the signer or the certifier is an unauthorized one.

It is very rare that the formula (1) is met in spite of the fact that the signer or the certifier forged the signed message by using the false secret key, because, assuming that the length of the message M is 200 bits, a probability that the formula (1) is met by the false secret key S is $1/2^{200} \fallingdotseq 6 \times 10^{-61}$, which is negligibly small.

It is difficult for a third person to steal the secret key of the signer or certifier and transact as if he were the signer or certifier, because the true signer and certifier, who are also the persons concerned, can detect a third person who transacts in place of the signer or certifier once the D (M, SK_S) or D (M, SK_R) is disclosed.

Where the key K for D (*, K) is kept in secret, it is difficult for a third person who is unaware of the secret key K to forge a key K' for the message M to meet D (M, K) = D (M, K').

The D (M, K) thus prepared is hereinafter referred to as an electronic seal by the owner of the secret key K, and the message M for certifying the validity or authenticity of the electronic seal is referred to as certificate data. If a person who received the electronic seal has a corresponding public key, he/she can detect who prepared the electronic seal and the content of the message. However, other person than the owner of the secret key K cannot produce the electronic seal D (M, K) based on the certificate data M. The same certificate data is decoded by the signer and certifier by their respective secret keys and the decoded results D (M, SK_S) and D (M, SK_R) are exchanged between both. The certifier can confirm that the sender of D (M, SK_S) is the signer himself if the certifier can get M in accordance with the formula - (1) by encoding D (M, SK_S) by the public key PK_S of the signer. The signer can also confirm that the sender pf D (M, SK_R) is the certifier himself if the signer can get M in accordance with the formula - (1) by encoding D (M, SK_R) by the public key PK_R of the certifier. When the persons concerned are presented with D (M, SK_S) and D (M, SK_R) from the signer or certifier, they encode D (M, SK_S) and D - (M, SK_R) by using the public key PK_S of the signer and the public key PK_R of the certifier. The persons concerned can determine whether the secret key used is authorized one or not by checking if the formula (1) is met or not.

② Addition of content certificate function

In order to certify the content of the trans mitted data, a message I is data compression encoded (Fig. 2) by using the key K. High order m bits of the finally produced block O_n is used as a Hash total (I, K) for the message I.

Assuming that m = 64 and different messages I and I' are data compression encoded, a probability of

$C\ (I',\ K) = C\ (I,\ K).....\ (3)$

is $1/2^{64} \fallingdotseq 5 \times 10^{-20}$, which is almost null.

When the signer sends a message, he/she data-compression-encodes it and opens the Hash total (data compression encoded message) to the persons concerned. The signer and certifier keep the originals of the message. Thus, if an issue later occurs on the original, the original may be again data-compression-encoded to check whether it matches to the initial original.

The message I may be used as an encoding key in an encoding system for certifying the content. A predetermined input data I0 is encoded by the encoding key to produce a Hash total C (I0, I). In the present encoding system, it is difficult to determine the encoding key I from the input data I0 and the output data C (I0, I) which both have been received.

Assuming that the length of the output data is 64 bits and diferent messages I and I' are used as the encoding key, a probability of

C (IO, I') = C (IO, I)..... (4)

is $1/2^{64} \fallingdotseq 5 \times 10^{-20}$, which is almost null.

The C (IO, I) is inserted in the certificate data at a predetermined position so that C (IO, I) is reproduced from the certificate data. When the signer, certifier or person concerned gets the message I' and C (IO, I), he/she first encodes the data IO by using the message I' as a key, and then compares the encoded result or Hash total C (IO, I') with C (IO, I). If they are equal, it means that the given message I' is equal to the original message I, and if they are not equal, it means that the given message I' is not equal to the original data I.

③ Double check of the signer and certifier by the possession of the secret key and the terminal response

The transaction procedure is established such that the signer and certifier respond to the call from the partner before they inputs their own secret keys. Thus, if the secret key is stolen by a third person, who intends to involve in the electronic transaction, at least one call is made by the signer or certifier before the transaction is executed. Accordingly, the signer or certifier can detect the third person's involvement.

④ Addition of time limit of effective period of electronic seal

When the signer and certifier make their electronic seals and tally impressions, they add dates which indicate the effective period of the electronic seals and tally impressions. This indicates to the transaction partner who received the electronic seal and tally impression a due date to respond, and declares that the transaction will be terminated and the electronic seal and tally impression so far exchanged will become ineffective unless response is received by the due date. If the signer or certifier does not receive the response to the electronic seal and tally impression he/she sent, he/she informs it to the authentication organization together with the electronic seal and tally impression so that the electronic seal and tally impression are invalidated. Thus, if the signer or certifier intentionally attempts to delay the execution of the transaction by non-returning the response, the authentication organization authenticates that the electronic seal and tally impression so far exchanged are invalid and the transaction has been terminated. Accordingly, safety in the transaction procedure is assured.

⑤ Addition of grace period for electronic seal

When the signer or certifier prepares his/her electronic seal and tally impression, he/she adds a grace period date for the electronic seal and tally impression at a predetermined position on the certificate data. This means to indicate to the partner of transaction who received the electronic seal and tally impression a grace period during which the partner is permitted to terminate the transaction. Before or during the grace period, the partner can terminate the transaction and declare that the electronic seal and tally impression so far exchanged are invalid. Thus, if the signer or certifier finds any defect in the transaction or finds that the electronic seal or tally impression received from the partner is unauthorized one, after the signer or certifier has sent the electronic seal and tally impression, he/she informs it to the authentication organization together with the electronic seal and tally impression so that the electronic seal and tally impression are invalidated. Thus, if an invalid transaction is made or if an opposition is lodged to the received electronic seal or tally impression, the authentication organization will authenticate that the electronic seal and tally impression so far exchanged are invalid and the transaction has been terminated. Accordingly, safety in the transaction procedure is assured.

⑥ Transmission of tally impression from certifier to signer

When the certifier receives the message M from the signer and confirms the content of the message M and agrees to the transaction, he/she prepares Hash totals $h_1 = H_1(M)$ and $h_2 = H_2(M)$ for a predetermined data IO, and combines high order bit sequence h_1 with a time data T to produce a tally impression certificate data (T, h_1). The tally impression certificate data is decoded by the secret key SK_R of the certifier to prepare an electronic tally impression $D((T, h_1), SK_R)$, which is sent to the signer as a response of agreement to the transaction by the message M. The signer encodes the electronic tally impression $(D((T, h_1), SK_R)$ by the public key PK_R of the certifier to produce the original tally impression certificate data $E(D((T, h_1), SK_R), PK_R) = (T, h_1)$. The signer confirms the fact that the high order bit sequence h_1 of the Hash total of the message M is included in the electronic seal which can be prepared only

by the certifier, and the signer may use it as a counterevidence when the certifier later denies the fact of transaction and does not send back the electronic seal of the certifier and escapes with the electronic seal of the signer.

The present invention is now explained for specific embodiments.

Fig. 5 shows a configuration of an electronic transaction system to which the present invention applies. Fig. 6 shows a flow chart of a procedure for embodying the present invention in the configuration of Fig. 5.

Where a creditability of journal management in an intermediation terminal 406 of Fig. 5 is high, the elements in Fig. 5 are operated in accordance with the flow chart shown in Fig. 6.

Step 601:

A signer 401 prepares a contract I by a signer terminal 404 and records it in the signer terminal 404. He/she also enters a name of the signer 401 and a name of a certifier 409 to the signer terminal 404.

Step 602:

The signer terminal 404 sends the contract I and the name of the signer 401 to a certifier terminal 407 via the intermediation terminal 406.

Step 602(a):

The intermediation terminal 406 records the transmitted contract I.

Step 603:

The certifier terminal 407 calls the certifier 409 and displays the contract I and the name of the signer 401.

Step 604:

The certifier 409 watches the display of the certifier terminal 407 to confirm the contract of the signer 401 and depress a certificate accept button.

Step 605:

The certifier terminal 407 prepares received date as a certificate data such as "14:35:14, February 19, 1985".

Step 606:

The certifier 409 inputs a certifier secret key SK_R.

Step 607:

The certifier terminal 407 prepares a certifier electronic seal $T = D(M, SK_R)$ by decoding the certificate data M by the secret key SK_R of the certifier 409, and sends it to the signer 401 at the signer terminal 404 via the intermediation terminal 406.

Step 608:

When the intermediation terminal 406 receives T, it immediately opens it to persons concerned by transmitting it to the persons concerned, or printing it on publication.

Step 609:

When a signer terminal 404 receives T, it encodes it by the certifier public key PK_R to reproduce the original certificate data.

$$M = E(D(M, SK_R), PK_R)$$

It checks the content of the certificate data and checks the following.

(1) If the time shown in the M is close to the reception time at the signer terminal 404, whether the true certifier 409 is actually present at the certifier terminal 407.

(2) If the time shown in the M is far from the reception time of the signer terminal 402 or makes no sense, it is judged that a false certifier is present at the certifier terminal 407.

In the present example, M is "14:35:14 February 19, 1985" and the decision (1) is made. If (2) is met, a message to terminate the transaction is sent to the certifier 409.

Step 610:

The signer 401 enters the signer secret key SK_S to the signer terminal 404.

Step 611:

The signer terminal 404 decodes the certificate data by using the signer secret key SK_S to the reproduced certificate data to prepare a signer electronic seal V.

$V = D(M, SK_S)$

Step 612:

The signer terminal 404 sends the V prepared in the step 611 to the certifier terminal 407 via the intermediation terminal 406.

Step 613:

The intermediation terminal 406 data-compression-encodes the set of V and I by using an intermediation terminal secret key B.

$W = C(B, (V, I))$

The contract I has been recorded in the intermediation terminal 406 in the step 602 (a). The V and W are opened to the persons concerned in the same manner as that in the step 608.

Step 614:

When the certifier terminal 407 receives the V, it encodes it by using the signer public key PK_S.

$M' = E(V, PK_S)$

$= E(D(M, SK_S), PK_S)$

Step 615:

The certifier terminal 407 checks if the encoded result M' in the step 614 matches to the certificate data M in the step 605.

(1) If M' matches to the certificate data prepared in the step 605, it is judged that the signer 401 himself/herself is actually present at the signer terminal 404 and a transaction accept signal is sent to the intermediation terminal 406.

(2) If M' does not match to the certificate data M prepared in the step 605, it is judged that a false signer is present at the signer terminal 404 and a transaction reject signal is sent to the intermediation terminal 406.

Step 616:

When the intermediation terminal 406 receives the transaction accept signal, it sends a signal of transaction agreement to the signer terminal 404 and certifier terminal 407 and records T, V and W. The contract I is deleted from the record.

When the intermediation terminal 406 receives the transaction reject signal, it sends a signal of transaction disagreement to the signer terminal 404 and certifier terminal 407, and deletes the records of T, V, W and I.

Step 617:

When the certifier terminal 407 receives the signal of transaction success, it records the contract I and the T, V, W in the file 411, and the certifier keeps the file 411.

Step 618:

When the signer terminal 404 receives the signal of transaction success, it records the contract I and the T, V, W in the file 403, and the signer 401 keeps the file 403.

Modification 1 of the first embodiment.

If the contract I is confidential information, the encoding of the contract by a conventional cryptograph may be added. A secret key X of the conventional cryptograph has been previously exchanged between the signer and the certifier, and the secret key X is also sent to the intermediation terminal 406. The steps 602, 602 (a) and 603 are modified as follows.

Step 602:

The signer terminal 404 prepares a cryptograph I' by encoding the contract I by using the secret key X of the conventional cryptograph. Then, the signer terminal 404 sends the cryp-

tograph I' of the contract and the name of the signer 401 to the certifier terminal 407 via the intermediation terminal 406.

Step 602 (a):

The intermediation terminal 406 decodes the cryptograph I' of the contract by using the secret key X of the conventional cryptograph to prepare the original contract I. Then, the intermediation terminal 406 records the name of the signer 401, the name of the certifier 409 and the contact I.

Step 603:

The intermediation terminal 406 decodes the cryptograph I' of the contract by using the secret key X of the conventional cryptograph to prepare the original contract I. Then, the certifier terminal 407 calls the certifier 409 and displays the contract I and the name of the signer 401.

Modification 2 of the first embodiment

In the step 606 or 610 of the first embodiment, if the certifier secret key SK_R or signer secret key $SK_S$to be entered by the certifier or signer is long, a certain number of bits of the secret key may be recorded on a magnetic card and the remaining bits are memorized by the certifier 409 or signer 401 as a secret number. When the certifier 409 or signer 401 enters the secret key, he/she sets the magnetic card and enters the secret number, and the terminal synthesizes the secret key based on those input information.

In a second embodiment, a high creditability is not put on the intermediation terminal 406 of Fig. 5 but the journal information is replaced by the electronic seal to eliminate the journal management. The operations of the elements in Fig. 5 are explained with reference to a flow chart of Fig. 7.

Step 501:

The signer 401 enters a transaction message I to the signer terminal 404 and enters the secret key SK_S of himself/herself, the name of the signer 401 and the name if the certifier 409.

Step 502:

The signer terminal 404 prepares E_k (I) by encoding the transaction message I by using the cryptograph key k, and sends E_k (I) , the name of the signer 401 and the name of the certifier 409 to the certifier terminal 407.

Step 503:

The certifier terminal 407 decodes the transaction message I by using the cryptograph key k.

$$I = D_k\ (E_k\ (I))$$

and it displays the transaction message I on a screen of the certifier terminal 407.

Step 504:

The certifier watches the transaction message I displayed on the display screen of the certifier terminal 407, and if he/she judges that he may proceed with the transaction, he/she enters his/her secret key SK_R.

Step 505:

The certifier terminal 407 prepare data T of a predetermined format. For example, the data T represents a current time such as "15:32:12 April 11, 1985".

Step 506:

The data D is decoded by using the secret key R in a predetermined public key cryptograph system to prepare D (T, SK_R), which is sent to the signer terminal 404 via the intermediation terminal 406.

Step 507:

The intermediation terminal 406 starts its operation in response to the reception of D (T, SK_R).

Step 508:

The signer terminal 404 encodes D (T, SK_R) by using the certifier public key PK_R to prepare T' = E (D(T, SK_R), PK_R). If T' matches to the predetermined format, it is judged that the certifier 409

himself/herself is actually present at the certifier terminal 407. In the present example, since the content of T' is same as that of T, that is, "15:53:12 April 11, 1985", the above judgement is made.

Step 509:

The signer 401 knows that the certifier 409 himself/herself is present at the certifier terminal 407 and the certifier 409 has judged to accept the transaction of the transaction message I. The signer 401 depresses the seal accept button of the signer terminal 404 in order to prepare his/her electronic seal.

Step 510:

The signer terminal 404 prepare the following cryptograph data C (I0, I) by using the transaction message I as the cryptograph key.

(1) $CI_i(I0)$ is a j-bit length output data derived by encoding a j-bit length input data I0 by an m-bit length cryptograph key I_i. The cryptograph system has been predetermined. In this cryptograph system, it is difficult to determine the cryptograph key I_i based on the input data I0 and the output data IC_i (I0).

(2) The transaction message is sectioned into n m-bit blocks I_1, I_2, ... I_n. If the length of the last block I_n does not reach m bits, "I" bits are added to attain the m-bit block I_n.

(3) The input data I0 is encoded by the Key I ($_1$to produce O_1.

CI_1 (I) → OI

i = 1

(4) O_i is encoded by the key I_{i+1} to produce O_{i+1}.

CI_{i+1} (O_i) → OI_{i+1}

(5) i+1 → i. If i ≤ n-1, the process returns to (4). Otherwise, O_{i+1} = O_n is outputted.

The encoded message O_n is called a Hash total of the transaction message I and expressed by C (I0, I).

C (I0, I) = O_n

T and C (I0, I) are combined to prepare

W = (T, C(I0, I))

Step 511:

W is decoded by the public key cryptograph system by using the secret key SK_S to prepare the electronic seal D (W, SK_S), which is sent to the certifier terminal 407 via the intermediation terminal 406.

Step 512:

The intermediation terminal 406 records D (W, SK_S).

Step 513:

The certifier terminal 407 encodes D (W, SK_S) by the signer public key PK_S to prepare W'.

W' = E (D(W, SK_S) , PK_S)

It also prepares a Hash total C (IO, I) to the transaction message I in the same manner as the step 510.

If T' = T and C (IO, I') = C (IO, I) when W' = (T' , C(IO, I')), "T' = T and C (IO, I') = C(IO, I)" is displayed on the screen.

Step 514:

The certifier 409 watches "T' = T and C (IO, I') = C (IO, I)" displayed on the certifier terminal 407 to judge that D (W, SK_S) was prepared by the signer 401 himself/herself based on the transaction message I, and decides to prepare and send the electronic seal of the certifier 409 himself/herself. He/she depresses an electronic seal prepare/send button of the certifier terminal 407.

Step 515:

The certifier terminal 407 decodes W by the public key cryptograph system by using the certifier secret key SK_R to prepare the electronic seal D (W, SK_R). It sends D (W, SK_R) to the intermediation terminal 406 and the signer terminal 404.

Step 516:

The intermediation terminal 406 records D (W, SK_R).

Step 517:

The signer terminal 404 encodes D (W, SK_R) by the public key cryptograph system by using the certifier public key PK $_R$ to prepare W".

W" = E (D(W, SK_R) , PK $_R$)

If W' = W, it is judged that D (W, SK_R) was prepared by the certifier 407 himself/herself based on the transaction I, and the signer terminal 404 sends a signal "acknowledged" to the intermediation terminal 406.

Step 518:

When the intermediation terminal 406 receives the "acknowledged" signal from the signer terminal 404, it erases the recorded D (W, SK_S) and D (W, SK_R) and terminates the operation.

Step 519:

The signer terminal 404 records the transaction message I, electronic seal D (W, SK_S) of the signer 401 and electronic seal D (W, SK_R) of the certifier 409 in the certifier file 411, and terminates the operation.

Step 520:

The certifier terminal 407 records the transaction message I, electronic seal D (W, SK_S) of the signer 401 and electronic seal D (W, SK_R) of the certifier 409 in the certifier file 411, and terminates the operation.

Step 521:

The signer 401 keeps the signer file 403.

Step 522:

The certifier 409 keeps the certifier file 411.

Modification 1 of second embodiment

In the step 518 of the second embodiment, the intermediation terminal 406 may record the electronic seals D (W, SK_S) and D (W, SK_R) instead of erasing them to keep them as an evidence of transaction.

Modification 2 of second embodiment

In the steps 501 and 504 of the second embodiment, a portion of information on the secret key may be recorded in a magnetic card or IC card and the signal/certifier memorizes the rest of the information on the secret key as a secret number. When the secret key SK_R is to be entered, the secret key is synthesized from the readout of the information from the magnetic card or IC card and the key entry of the secret number.

Modification 3 of second embodiment

In the step 501, 504, 509 or 514 of the second embodiment, a checking function of the person by voice pattern or fingerprint before input operation may be added to the terminal.

Fig. 8 shows a flow chart of a procedure for transacting by an electronic seal with a time limit for an effective period in accordance with a third embodiment of the configuration shown in Fig. 5.

Steps 711 -713 which are different from the flow chart of Fig. 7 are primarily explained.

Step 711:

The signer terminal 404 prepares the time limit of the effective period of the electronic seal in a predetermined data format to set the time limit V. For example, the time limit V is "17:30:00 April 11, 1985".

The previously prepared T and C (IO, I) and the V are combined to prepare

W = (V, T, C (IO, I))

Step 511:

W is decoded by the public key cryptograph system by using the secret key SK $_S$ to prepare D (W, SK_S) , which is sent to the certifier terminal 407.

Step 712:

The certifier terminal 407 encodes D (W, SK_S) by the signer public key SK_R 408 to prepare W'.

W' = E (D(W, SK_S), SK_R)

It also prepares a Hash total C (IO, I) for the transaction message I in the same manner as the step 510.

If T' = T and C (IO, I') = C (IO, I) and V' is of a predetermined format when W' = (V', T', C (IO, I)), then "T' = T and C (IO, I') = C (IO, I)" and "Time limit of electronic seal = V' " are displayed on the screen. In the present example, the content of V' is same as that of V, that is, "15:30:00 April 11, 1985".

Step 713:

The certifier 409 watches "T' = T and C (IO, I') = C (IO, I)" and "Time limit of electronic seal = V' " displayed on the certifier terminal 407 and judges that D (W, SK_S) was prepared by the signer 401 himself/hersel based on the transaction message I and the time limit is V', and decides to prepare and send the electronic seal of the certifier. He/she then depresses the electronic seal prepare/send button of the certifier terminal 407.

In the third embodiment, the second and third modifications of the second embodiment equally apply.

In accordance with the above first and second embodiments, the electronic transaction which meets the following conditions is provided.

[I] Advantages concerning the first embodiment

(1) Only the sender can prepare the signed message. It cannot be forged by a third person.

This is because the encoded message V of the certificate data can be prepared only by using the secret key SK_S which is owned only by the signer. If the third person attempts to transact with V' other than V of the certificate data, the certifier can detect in the step 614 that the signer is a false one, and the persons concerned who have the public key PK_S can detect that the transaction is not effective because the encoded results of T and V publicized by the intermediation terminal, by using the public key PK_S of the certifier and signer do not match each other.

(2) The receiver cannot modify the signed message.

The set of the encoded message V of the certificate data and the contact message I is data-compression-encoded by the secret key B of the intermediation terminal and the resulting Hash total W is recorded and opened to the persons concerned. Accordingly, if one of the parties who has the encoded message V of the certificate data and the contract message I brings the data and encodes the contract message by the certifier public key PK_R in font of the other party, and causes the intermediation terminal to data-compression-encode the set of the encoded message and V to produce W', and W' is compared with the previously opened result W, then the content certification is attained. If W = W', the contents are identical and if W = W', the contents are not identical.

Because the encoded messages T and V of the certificate data are opened to the persons concerned during the transaction, the persons concerned can check who are now transacting. Accordingly, it is hard to a third person who has stolen the secret key to conduct an unauthorized transaction as if he were the sender or receiver.

(3) The sender and receiver cannot later deny the fact of transmission and reception.

In order for the electronic transaction to be effective, the party must enter its secret key at least once and responds to the call from the other party. That is, the party is double-checked. When the party responds to the call in the terminal, the person may be checked by the fact that he/she has the magnetic card as shown in the modification 2 of the embodiment, or the person may be checked by the voice pattern or fingerprint so that the personal check function is further enhanced.

Since the encoded messages T and V of the certificate data are opened to the persons concerned during the transaction, the persons concerned can check who are now transacting. Accordingly, it is hard for a third person who has stolen the secret key to conduct an unauthorized transaction as if he/she were sender or receiver because it may be detected by the true sender or receiver or the persons concerned.

The Hash total W for assuring the content of the contract message I is once opened and then recorded and kept in the intermediation terminal. It is therefore difficult to deny the fact of transmission or reception by modifying or destroying the record.

In the present system, the content of communication is not disclosed when the data is opened at the intermediation terminal. What is opened at the intermediation terminal is not the communication text itself but the Hash total which is prepared by data-compression-encoding the set of the communication text and the encoded message of the certificate data. It is impossible to estimate the communication text based on the Hash total.

Since the data which the intermediation terminal records and keep are the certificate data T and V and the Hash total W, the load for maintenance is lower than that when the entire contract message I is maintained.

[II] Advantages concerning the second embodiment

(1) The third person cannot conduct transaction as if he/she were the signer by the following reasons.

(a) Check of possession of secret key.

The electronic seal D (W, SK_S) can be prepared only by using the secret key SK_S which only the signer possesses. If the third person prepares the electronic seal D (W, SK_S') by the key SK $_S$' other than the secret key SK_S, the certifier terminal detects that it is a false electronic seal in the step 513.

It is difficult for the third person to conduct the transaction unless he/she knows the secret key of the signer.

(b) Check by response to call

The third person who attempt to conduct an unauthorized transaction must depress the seal accept button in the step 509. The certifier depresses the transaction accept button in the step 504 and the call is made to the signer in the step 508. Accordingly, it is hard for the third person to conduct the transaction unless he/she prevents the signer from responding to the call.

(2) Third person cannot conduct unauthorized transaction as if he/she were certifier by the following reasons.

(a) Check by the possession of secret key

The electronic seal D (W, SK_R) can be prepared only by using the secret key SK_R which is possessed only by the receiver. If the third person prepares the electronic seal D (W, SK_R) by the key SK_R' other than the secret key SK_R, the signer terminal detects that it is a false electronic key in the step 517. The same is true for the decoded message D (T, SK_R) of the ID. A false message D - (T, SK_R') is detected in the step 508. Accordingly, it is hard for the third person to conduct the transaction unless he/she knows the secret key of the third person.

Check by response to call

The third person who attempts to conduct the unauthorized transaction must depress the transaction accept button and the seal accept button in the steps 504 and 514. The call to the signer is first made, and then the call to the certifier is made in the certifier terminal. Accordingly, it is hard for the third person to conduct the transaction unless he/she prevents the certifier from responding to the call.

(3) Certifier cannot modify the transaction message by the following reasons.

(a) Check by possession of secret key

Let us assume that the certifier prepared a forged message I' of the transaction message I. In this case, the certifier cannot prepare the electronic seal D (W', SK_S) which the signer should have prepared.

W' = (T, C (IO, I))

Since the certifier is unaware of the secret key SK_S of the signer, he/she cannot prepare D (W', SK_S) when W' is given. Let us assume that the certifier has prepared D (W', SK_S) by using the key SK_S having a bit length of 200 bits. A probability that

D (W', SK_S') = D (W, SK_S)

is $1/2^{200}$ 6 x 10^{-61}, which is practically null. If a third person in a fair position calculates E (D(W', SK_S), PK_S) and E (D(W', SK_R), PK_R) for the certifier data I', and D (W', SK_S') and D (W', SK_R), those do not match. It is thus seen that one of the electronic seals is false and the data set of the certifier is invalid. If SK_s' is the true secret key,

W' = E (D(W', SK_S'), PK_S)

= E (D(W', SK_R), PK_R)

should be met. Accordingly, it is hard for the third person to modify the contract message unless he/she is aware of the secret key of the signer.

Check by response to call

In the modification 1 of the embodiment, the evidences of the electronic seals D (W, SK_S) and D (W, SK_R) must have been left in the step 518. The certifier who attempts to modify the transaction message must prepare the response to the call by the signer in the step 509 in order to leave the record. Accordingly, even if the certigier could know the secret key SK_S of the signer, it is difficult for the certifier to modify the transaction message unless the certifier can issue the response in the step 509 without being noticed by the signer.

(4) Signer cannot deny the content of transaction after transaction has been executed.

This is by the same reason as that for (3) in which the certifier cannot modify the transaction message.

In the present system, the content of communication is not disclosed in the intermediation terminal. The information transmitted to the intermediation terminal is not the communication text itself but the Hash total derived by data-compression-encoding the communication text, and it is impossible to guess the original communication text from the Hash total.

(5) Certifier cannot escape with electronic seal of signer

(a) Check by time limit of electronic seal

The electronic seal D (W, SK_S) of the signer includes the time limit V for the electronic seal which the signer has prepared in the predetermined form.

W = (V, T, C (IO, I))

If the response from the certifier is not received before the time limit V, the signer judges that the certifier has no intention to conduct the transaction and invalidates the electronic seal D (W, SK_S) by informing the electronic seal to the authentication organization. As a result, it is impossible for the certifier to escape with the electronic seal and make unauthorized use thereof. The authenication organization has a function to assure the invalidation of the electronic seal and it is utilized only when the necessity to prove the invalidity of the electronic seal arises.

Fig. 9 shows another configuration of the electronic transaction system to which the present invention is applied, and Fig. 10 shows a flow chart of a procedure in a fourth embodiment of the present invention in the configuration of Fig. 9.

The operations of the elements of Fig. 9 are explained with reference to the flow chart of Fig. 10.

Step 5010:

The signer 401 enters the transaction message M from a message file 4020 to a signer electronic transaction unit 404, and enters his/her secret key SK_S, the name of signer 401 and the name of the certifier 426 by an IC card 4030.

Step 5020:

The signer electronic transmission unit 404 encodes the transaction message M by using the message cryptograph key K of a message encoder 4050 and a memory 4060 to prepare EK(M), and sends EK(M), the name of the signer 401 and the name of the certifier 426 to the certifier electronic transaction unit 423 through a communication control unit 413.

Step 5030:

The signer electronic transaction unit 404 prepares a compressed cryptograph H(M) by a compression function generator 4070 by using the transaction message M as a cryptograph key.

(1) H(M) is in 8-bit output data derived by compression-encoding an 8-bit input data I(O) by an 8-bit cryptograph key K1. The cryptograph system has been predetermined. In this cryptograph system, it is difficult to determine the cryptograph key K1 based on the input data I(O) and the output data H(M).

(2) The transaction message is sectioned into n 56-bit blocks M1, M2, ••• Mn. If the length of the last block Mn does not reach 56 bits, bits "0" are added until the length of the block Mn reaches 56 bits.

(3) One parity bit is added to every seven bits of the blocks so that the block length is expanded to 64 bits. The expanded blocks are designated by K1, K2, ••• Kn.

(4) The input data I(i-1) is encoded by the key Ki, and the encoded result is exclusively ORed with I(i-1) to produce I(i).

I(i) = I(i-1) + EKi (I(i-1))

The above process is repeated for i = 1, 2, ••• n. The initial value I(0) is a predeterminer one.

(5) The finally determined I(n) in the step (4) is used as H(M), which is divided into high order and low order data h1 and h2.

H(M) = (h1, h2) = I(n)

Step 5040:

The certifier electronic transaction unit 423 decodes the encoded message EK(M) by using the message encoder 422 and the cryptograph key K.

M = DK (EK(M))

It informs the transaction message M to the certifier 426.

Step 5050:

The certifier 426 watches the transaction message M decoded in the step 5040, and if he/she judges that the transaction may be proceeded, he/she enters his/her secret key SK_R by the IC card 424.

Step 5060:

The certifier electronic transaction unit 423 compression-encodes the transaction message M by using the compression encoder 420 in the same manner as the step 5030 to prepare H(M) = (h1, h2). It also prepares a data in a predetermined format as an ID T by a clock generator 417. In the present example, the ID T may be a current time, for example, "15:53:12 April 11, 1985".

Step 5070:

A tally impression certificate data W1 is prepared by a certificate data preparation circuit 418 from the ID T and the high order data h1 derived from the encoded data H(M) by a divider 419.

W1 = (T, h1)

Step 5080:

The tally impression certificate data W1 is decoded by the seal/tally impression encoder 415 by using the secret key SK_R by the predetermined public key cryptograph system to prepare D (W1, SK_R), which is sent to the signer electronic transaction unit 404.

Step 5090:

The signer electronic transaction unit 404 encodes D (W1, SK_R) by the seal/tally impression encoder 412 by using the certifier public key PK_R of the memory 4060 to prepare W1' = (E (D(W1, SK_R), PK_R). The encoded result W1' is compared by the comparator 4110. If T' matches to the predetermined format and h1' is equal to h1 prepared in the step 5030, it is judged that the certifier 426 himself/herself is present at the certifier electronic transaction unit 423. In the present example, the content of T' is equal to that of T, that is, "15:53:12 April 11, 1985" and the above judgement is made.

Step 5100:

The signer 401 notifies that the certifier 426 hinself/herself is at the certifier electronic transaction unit 423 and the certifier 426 has decided to accept the transaction for the transaction message M. The signer 401 depresses the seal accept button to prepare his/her electronic seal.

Step 5110:

The signer electronic transaction unit 404 enters (h1, h2) prepared in the step 5030 and T' prepared in the step 5090 to the certificate data preparation circuit 4090 to prepare the tally certificate data W2.

W2 = (T', h1, h2)

Step 5120:

The tally impression certificate data W2 is decoded by the seal/tally impression encoder 412 by using the secret key SK_S by the predetermined public key cryptograph system to prepare D (W2, SK_S), which is sent to the certifier electronic transaction unit 423.

Step 5130:

The certifier electronic transaction unit 423 encodes D (W2, SK_S) by the seal/tally impression encoder 415 by the signer public key PK_S of the memory 421 to prepare W2".

W2" = E (D(W2, SK_S), PK_S)

The comparator 4160 checks if T" = T and (h1", h2") = (h1, h2) when W2" = (T", h1", h2"), and informs the result to the certifier 426.

Step 5140:

When the certifier 426 confirms that the result in the step 5130 is "T" = T and (h1", h2") = (h1, h2)", he/she judges that D (W2, SK_S) has been prepared by the signer himself/herself based on the transaction message M, and decides to prepare and send the electronic seal of the signer. He/she depresses the electronic seal prepare/send button of the certifier electronic transaction unit 423.

Step 5150:

The certifier electronic transaction unit 423 prepares the seal certificate data W2 by the certificate data preparation circuit 418 from (h1, h2) and T prepared in the step 5060.

Step 5160:

The certifier electronic transaction unit 423 decodes W2 by the seal/tally impression encoder 415 by using the certifier secret key SK_R of the IC card 424 by the public key cryptograph system to prepare D (W2, SK_R), which is sent to the signer electronic transaction unit 404.

Step 5170:

The signer electronic transaction unit 404 encodes D (W2, SK $_R$) by the seal/tally impression encoder 412 by using the certifier public key PK_R of the memory 4060 by the public key cryptograph system to prepare W".

W2" = E (D(W2, SK_R), PK $_R$)

If the comparator 411 indicated that T" = T' and (h1", h2") = (h1, h2) when W2" = (T", h1", h2"), it is judged that D (W2, SK_R) has been prepared by the certifier 426 himself/herself based on the transaction message M.

Step 5180:

The certifier electronic transaction unit 404 records the transaction message M, the electronic seal D (W2, SK_R) of the signer 401 and the electronic seal D (W2, SK_S) and tally impression D (W2, SK_R) of the certifier 426 in the message file 4020, and terminates the operation.

Step 5190:

The signer 401 keeps the message file 4020.

Step 5200:

The certifier electronic transaction unit 423 records the transaction message M, the electronic seal D (W2, SK_S) of the signer 401 and the electronic seal D (W2, SK_R) and tally impression D (W2, SK_R) of the certifier 426 in the message file 425, and terminates the operation.

Step 5210:

The certifier 426 keeps the message file 425.

Modification 1 of the embodiment

In the steps 5010 and 5050 of the present embodiment, a portion of the information on the secret key is recorded in a magnetic card or IC card and the rest of the information of the secret key is memorized by the signer or certifier as a secret number. When the secret key SK_S or SK_R is to be entered, it is inputted by reading the information from the magnetic card or IC card and keying the secret number by the secret key SK_Sor SK_R.

Modification 2 of the embodiment

In the step 5010, 5050, 5100 or 5140 of the present embodiment, the terminal may confirm the person by the voice pattern or fingerprint before the signer or certifier enter the information.

In the present modification, the signer or certifier cannot escape with the electronic seal because of the tally impression check. If the certifier does not send the certifier's electronic seal D (W2,

SK_R) and denies the transaction after the signer has sent the signer's electronic seal D (W2, SK_R) when the signer and the certifier electronically transact the transaction message M, the signer may prove that the certifier attempts to deny the fact of transaction and escape with the signer's electronic seal by decoding the tally impression by the public key PK_R of the certifier and checking the content thereof. The tally impression D (W1, SK_R) sent by the certifier to the signer prior to the exchange of the electronic seal includes the high order data hl of H(M) = (h1, h2) prepared by compression-encoding the transaction message M sent by the signer.

W1 = (T, h1)

It is difficult to prepare the secret key which meets

$$D (W1, SK_R') = D (W1, SK_R)$$

by the same reason as the third person cannot conduct the transaction as if he/she were the certifier. Accordingly, it is only the certifier who has the secret key SK_R that can prepare the tally impression which includes the high order data of the compression-encoded message of the transaction message M.

Fig. 11 shows other configuration of the system of the present invention, and Fig. 12 shows a flow chart of a procedure in a fifth embodiment of the present invention in the configuration of Fig. 11. Operations of elements in Fig. 11 are explained with reference to the flow chart of Fig. 12.

Step 2010:

The signer 104 enters the transaction message M from the message file 110 to the signer electronic transaction unit 111.

Step 2020:

The signer electronic transaction unit 111 sends the input transaction message M to the certifier electronic transaction unit 122 by the communication control unit 107.

Step 2030:

The certifier electronic transaction unit 122 receives the transaction message M and displays it on the display 114.

Step 2040:

The certifier 112 confirms the transaction message M displayed on the display 114.

Step 205:

The certifier 112 reviews the content of the transaction message M and accepts to proceed with the transaction.

Step 206:

The certifier 112 enters the grace period T_1 of the certifier electronic tally impression N_1 and the sender/receiver ID to the certifier electronic transaction unit 122 by the keyboard 115.

Step 207:

The certifier electronic transaction unit 122 edits the input grace period T_1, sender/receiver ID, time information T_0 generated by the timer 120 and information for identifying the content of the transaction message M through the transaction status data edit circuit 118 to prepare (produce) the transaction status data $W_1 = (T_1, H_1)$.

Step 208:

The certifier electronic transaction unit 122 encodes the transaction status data W_1 by the seal/tally impression encoder 117 by using the secret key SK_R of the certifier read from the IC card 113 to prepare (produce) the certifier electronic tally impression $N_1 = E (SK_R, W_1)$, which is sent to the signer electronic transaction unit 111 by the communication control unit 116.

Step 209:

The signer electronic transaction unit 111 decodes the certifier electronic tally impression N_1 by the seal/tally impression encoder 1060 by using the public key PK_R of the certifier registered in the memory 109 to prepare the transaction status data $W_1 = D (PK_R, N_1)$, which is displayed on the display 1020.

Step 210:

The signer 1040 confirms the content of the transaction status data W_1 displayed on the display 1020 to check on the validity thereof.

Step 211:

The signer 1040 accepts to proceed with the transaction depending on the result of the validity check of the transaction status data W_1.

Step 212:

The signer 1040 enters the grace period T_2 of the signer electronic seal N_2 and the sender/receiver ID to the signer electronic transaction unit 111 by the keyboard 1010.

Step 213:

The signer electronic transaction unit 111 edits the input grace period T_2, sender/receiver ID, time information T_0 generated by the timer 108 and information for identifying the content of the transaction message M through the transaction status data edit circuit 1050 to prepare the transaction status data $W_2 = (T_2, H_2)$.

Step 214:

The signer electronic transaction unit 111 encodes the transaction status data W_2 by the seal/tally impression encoder 1060 by using the secret key SK_S of the signer read from the IC card 1030 to prepare the signer electronic seal $N_2 = E(SK_S, W_2)$, which is sent to the certifier electronic transaction unit 122 by the communication control unit 107.

Step 215:

The certifier electronic transaction unit 122 decodes the signer electronic seal N_2 of the seal/tally impression encoder 117 by using the public key PK_S of the certifier registered in the memory 119 to prepare the transaction status data $W_2 = D(PK_S, N_2)$, which is displayed on the display 114.

Step 216:

The certifier 112 confirms the content of the transaction status data W_2 displayed on the display 114 to check the validity thereof.

Step 217:

The certifier 112 accepts to proceed with the transaction depending on the result of the validity check of the transaction status data W_2.

Step 218:

The certifier 112 enters the grace period T_3 of the certifier electronic seal N_3 and the sender/receiver ID to the certifier electronic transaction unit 122 by the keyboard 115.

Step 219:

The certifier electronic transaction unit 122 edits the input grace period T_3, sender/receiver ID, time information T_0 generated by the timer 120 and information for identifying the content of the transaction message M through the transaction status data edit circuit 118 to prepare the transaction status data $W_3 = (T_3, H_3)$.

Step 220:

The certifier electronic transaction unit 122 encodes the transaction status data W_3 by the seal/tally impression encoder 117 by using the secret key SK_R of the certifier read from the IC card 113 to prepare the certifier electronic seal $N_3 = E(SK_R, W_3)$, which is sent to the signer electronic transaction unit 111 by the communication control unit 116.

Step 221:

The certifier electronic transaction unit 122 keeps the transaction message M and the electronic seals N_2 and N_3 of both parties in the message file 121.

Step 222:

The signer electronic transaction unit 111 decodes the certifier electronic seal N_3 by the seal/tally impression encoder 1060 by using the public key PK_R of the certifier registered in the memory 109 to prepare the transaction status data $W_3 = D(PK_R, N_3)$, which is displayed on the display 1020.

Step 223:

The signer 1040 confirms the content of the transaction status data W_3 displayed on the display 1020 to check the validity thereof.

Step 224:

The signer 1040 accepts to proceed with the transaction depending on the result of the validity check of the transaction status data W_3.

Step 225:

The signer electronic transaction unit 111 keeps the transaction message M and electronic seals N_2 and N_3 of both parties in the message file 110.

In the steps 211, 217 and 224 of the present embodiment, the grace period information indicating the period for permitting interruption of the transaction is included in the electronic seal and tally impression. If the party who received the electronic seal or tally impression lodges an opposition against the received electronic seal or tally impression within the grace period, he/she is ensured to invalidate the electronic seal or tally impression he/she already issued by reporting the termination of the transaction to the public organization by the third party. Thus, a dispute during and after the transaction can be prevented.

If the party who sent the electronic seal or tally impression wishes to terminate the transaction because something wrong was found later, the transaction can be terminated by reporting it to the public organization within the designated grace period. Thus, a wrong transaction is prevented.

The grace period may be sent to any period by the sender of the electronic seal and tally impression while taking the time necessary for the receiver to confirm the content into consideration. Thus, even if there is a difference between the processing speeds of the apparatus for preparing and checking the electronic seals and tally impression of both parties, the system can be flexibly operated. Thus, the safety of the transaction is assured where the apparatus having different performances such as a personal computer and a large scale computer.

In accordance with the present invention, unauthorized act by not only the parties but also the third person is prevented and a highly reliable electronic transaction system is attained.

Claims

1. An electronic transaction system for electronically transacting between first and second transacting party units (404, 407) by replacing a document with a computer message comprising:

an intermediation unit (406) intervening between said first and second transacting party units and including means for publicly displaying data;

display means in said intermediation unit for displaying a first decoded message derived by decoding a certificate data by the first transacting party by using a secret key of the first transacting party, and a second decoded message derived by decoding said certificate data by the second transacting party by using a secret key of the second transacting party; and

means for allowing to determine whether the transacting parties are said first and second transacting parties who have their own secret keys, by a party having a public key of the parties in response to display data on said display means of the intermediation unit based on the fact that a first encoded message derived by encoding the first decoded message by using the public key of the first transacting party coincides with a second encoded message derived by encoding the second decoded message by using the public key of the second transacting party.

2. An electronic transaction system according to Claim 1 wherein said intermediation unit includes said means for publicly displaying data as well as a third secret key and data recording means, stores therein said first and second decoded messages, receives transaction data each time the first or second transacting party sends the transaction data, data-compression-encodes a data prepared by arranging the first or second decoded message and the transaction data by using the third secret key, records and publicly displays the encoded result, data-compression-encodes the original communication message which the first or second transacting party possesses by using the third secret key based on the fact that any change of the original data affects to the result of the data com-

pression encoding, compares the encoded result with the recorded data-compression-encoded result to certify the content of the transaction data.

3. An electronic transaction system according to Claim 1 wherein the transaction is effective only when the transacting party has communicated with the other transacting party at least once and both transacting parties have used their own secret keys at least once.

4. An electronic transaction system for electronically transacting by replacing a document with a computer message, comprising:

means for exchanging between a first transacting party and a second transacting party a first decoded message derived by decoding a certificate data by a first transacting party by a public key cryptograph system by using a secret key of the first transacting party and a second decoded message derived by decoding said certificate data by a second transacting party by using a secret key of the second transacting party and keeping said first and second decoded messages;

means for encoding the first decoded message by using the public key of the first transacting party by a third party having the public keys of the first and second transacting parties and encoding the second decoded message by using the public key of the second transacting party by the third party when one of the first and second transacting parties provides the first or second decoded message to the third party; and

means for comparing the encoded results to determine whether the transacting parties are the first and second transacting parties having the secret keys based on the fact that the first encoded message derived by encoding the public key of the dirst transacting party and the second encoded message derived by encoding the second decoded message by using the public key of the second transacting party are equal.

5. An electronic transaction system according to Claim 1 wherein the certificate data includes a third encoded message derived by encoding a predetermined first data message by a predetermined third cryptograph system by using the transaction message in the transaction as a cryptograph key and a second data message of a predetermined format, said third cryptograph system has such a characteristic that it is difficult to find a cryptograph key other than the first transaction message which results in an encoded result of the third encoded message for the given first data message, one of the first and second transacting parties provides the first and second decoded messages to a third party who has the public keys of the first and second transacting parties and knows a third cryptograph system, as well as the transaction message so that the third party encodes the first decoded message by using the public key of the first transacting party and encodes the second decoded message by using the public key of the second transacting party, it is determined that the encoded result matches with the original certificate data if both encoded results are equal, and it is determined that the transaction message matches with the originally prepared transaction message if the result derived by encoding the first data message by the third encoding system by using the transaction message as the cryptograph key.

6. A electronic transaction system according to Claim 1 wherein when the first and second decoded messages are exchanged between the first and second decoded messages, said intermediation unit includes a storage, and the first and second decoded messages are exchanged between the transacting parties through the intermediation unit and the intermediation unit stores the first and second decoded messages until both parties receive the decoded message of the other, check the contents thereof and second signals to the intermediation unit.

7. An electronic transaction system according to Claim 5 wherein the second data message included in the certificate data includes information representing an effective period of an electronic seal in the transaction, the third encoding system has such a characteristic that it is very rare in probability that the same encoded result is obtained when different certificate data are given, and when one of the parties received a false decoded message or does not receive the decoded message from the other party within the effective period after he/she has sent the decoded message, he/she declares the termination of transaction to an authentication organization so that the invalidation of the decoded message he/she sent is assured by the authentication organization.

8. An electronic transaction system for electronically transacting by replacing a document with electric information, characterized in that certificate data each including data representing the acceptance of a transaction message derived by modifying information representing transaction status for each transacting party and data representing a grace period for permitting opposition to the transaction are exchanged to proceed with the transaction.

9. An electronic transaction system according to Claim 8 wherein the modification of the transaction status information is made by an asymmetric key cryptograph system, one of the asymmetric

key is secret, and information encoded by using the secret key is decoded by the other key. to identify and certify the transacting party.

10. An electronic transaction system according to Claim 8 wherein said grace period is determined by taking a time required to prepare and check the certificate data inherent to the transacting party into consideration, and invalidation of the certificate data issued by the transacting party is assured by an authentication organization by declaring the termination of the transaction to the authentication organization within the grace period when the transacting party has an opposition to the certificate data of the other transacting party.

11. An electronic transaction system for electronically transacting by replacing a document with electric information, comprising:

means for predetermining a first certificate data preparation method for preparing certificate data indicating that a transaction message has been informally accepted, and a second certificate data preparation method different from said first certificate data preparation method for preparing certificate data indicating that the transaction message has been formally accepted;

means for providing a first certificate data for the transaction message by the first certificate data preparation method by a first transacting party, and sending it to a second transacting party;

means for providing a second certificate data for the transaction message by the second certificate data preparation method by a second transacting party after the reception of the first certificate data from the first transacting party; and

means for providing a third certificate data for the transaction message by the second certificate data preparation method by the first transacting party after the reception of the second certificate data from the second transacting party to proceed with the transaction.

12. An electronic transaction system according to Claim 11 wherein said first certificate data preparation method uses a predetermined public key cryptograph system, encodes first transaction status data representing tansaction status by a secret key to prepare the certificate data, and said second certificate data preparation method uses a predetermined public key cryptograph system and encodes second transaction status data different from said first transaction status data by a secret key to prepare the certificate datà.

13. An electronic transaction system according to Claim 11 wherein said first transaction status data includes a first compression-encoded message derived by compression-encoding the transaction message by a first compression encoding method, and said second transaction data includes a second compression-encoded message derived by compression-encoding the transaction message by a second compression encoding method other than the first compression encoding method.

14. An electronic transaction method for electronically transacting between first and second transacting party units by replacing a deocument with a computer message comprising the steps of:

providing an intermediation unit intervening between said first and second transacting party units and including means for publicly displaying data;

displaying on said intermediation unit for a first decoded message derived by decoding a certificate data by the first transacting party by using a secret key of the first transacting party, and a second decoded message derived by decoding said certificate data by the second transacting party by using a secret key of the second transacting party; and

determining whether the transacting parties are said first and second transacting parties who have their own secret keys, by a third party having a public key of the parties by referring to the display on said intermediation unit based on the fact that a first encloded message derived by encoding the first decoded message by using the public key of the first transacting party and a second encoded message derived by encoding the second decoded message by using the public key of the second transacting party are equal.

15. An electronic transaction method for electronically transacting by replacing a document with a computer message, comprising the steps of:

exchanging between a first transacting party and a second transacting party a first decoded message derived by decoding a certificate data by a first transacting party by a public key cryptograph system by using a secret key of the first transacting party and a second decoded message derived by decoding said certificate data by a second transacting party by using a secret key of the second transacting party and keeping said first and second decoded messages;

encoding the first decoded message by using the public key of the first transacting party by a third party having the public keys of the first and second transacting parties and encoding the second decoded message by using the public key of the second transacting party by the third party when one of the first and second transacting parties

provides the first or second decoded message to the third party; and

comparing the encoded results to determine whether the transacting parties are the first and second transacting parties having the secret keys based on the fact that the first encoded message derived by encoding the public key of the first transacting party and the second encoded message derived by encoding the second decoded message by using the public key of the second transacting party are equal.

16. An electronic transaction method for electronically transacting by replacing a document with electric information, comprising the steps of:

predetermining a first certificate data production - scheme for producing certificate data indicating that a transaction message has been informally accepted, and a second certificate data production scheme different from said first certificate data production scheme for producing certificate data indicating that the transaction message has been formally accepted;

providing a first certificate data for the transaction message by the first certificate data production - scheme by a first transacting party, and sending it to a second transacting party;

providing a second certificate data for the transaction message by the second certificate data production scheme by a second transacting party after the reception of the first certificate data from the first transacting party; and

providing a third certificate data for the transaction message by the second certificate data production scheme by the first transacting party after the reception of the second certificate data from the second transacting party to proceed with the transaction.

FIG. 1 PRIOR ART

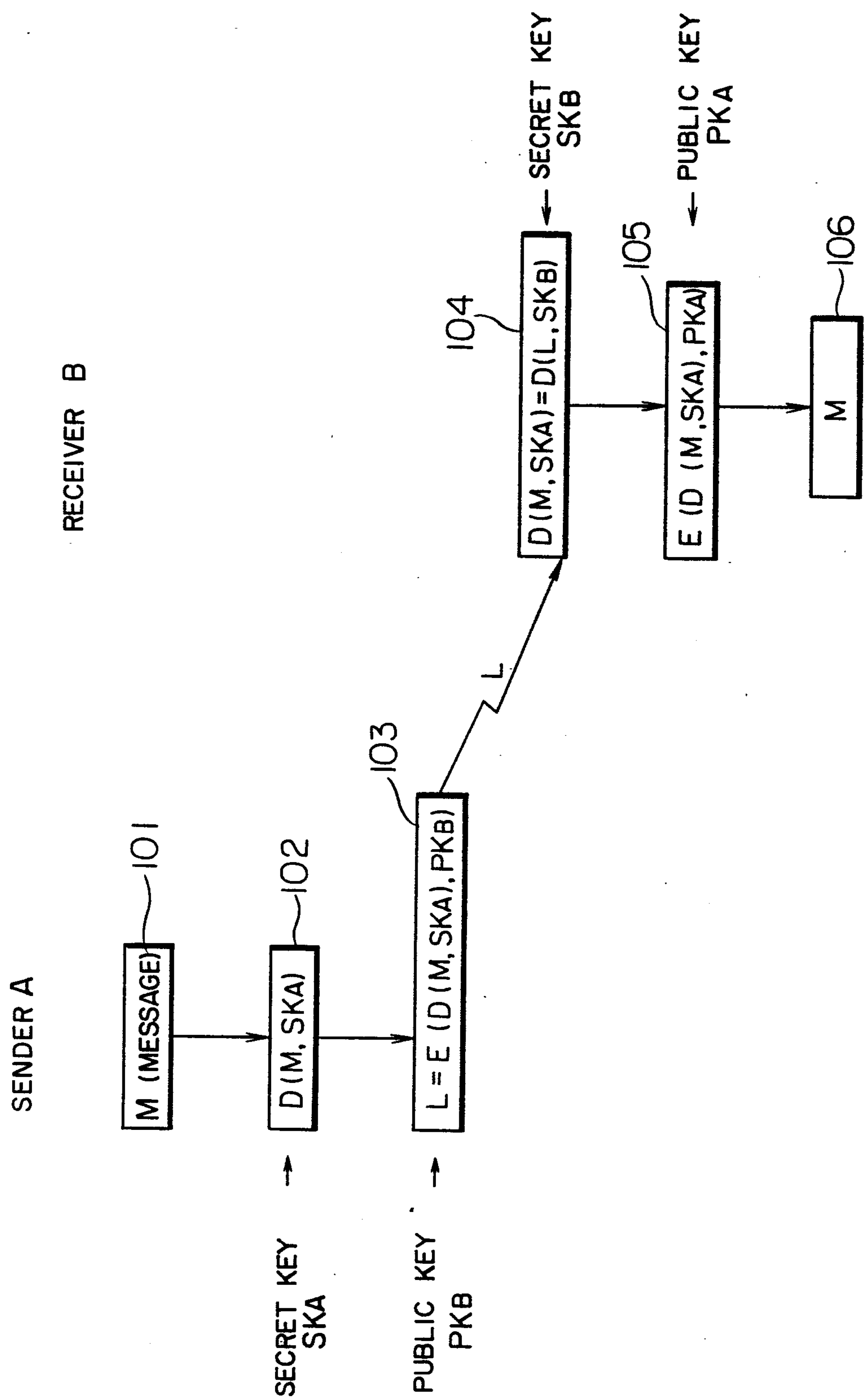


FIG. 2 A PRIOR ART

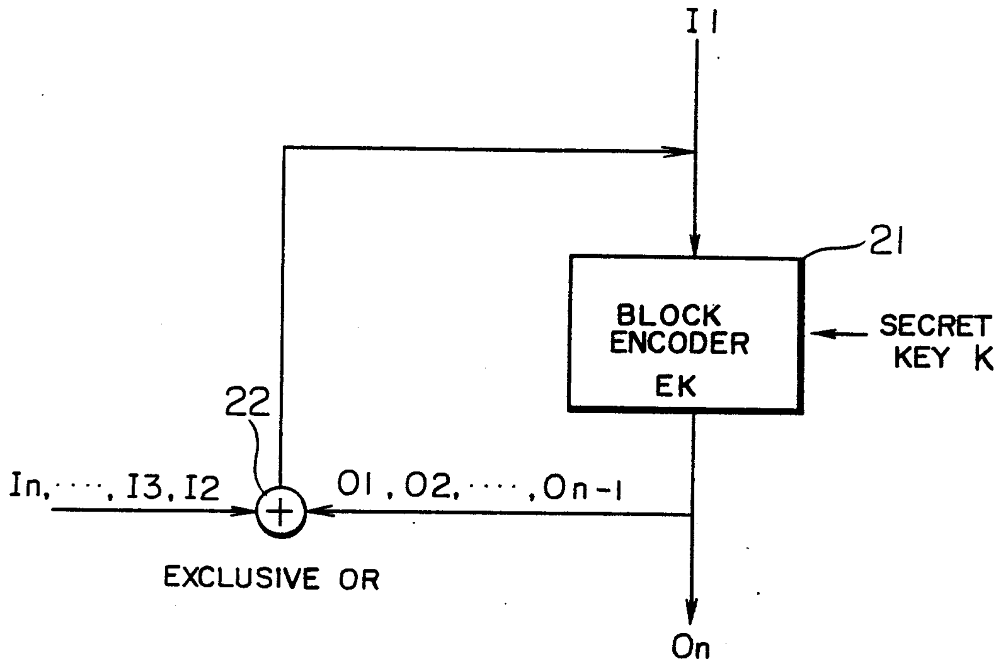


FIG. 3 PRIOR ART

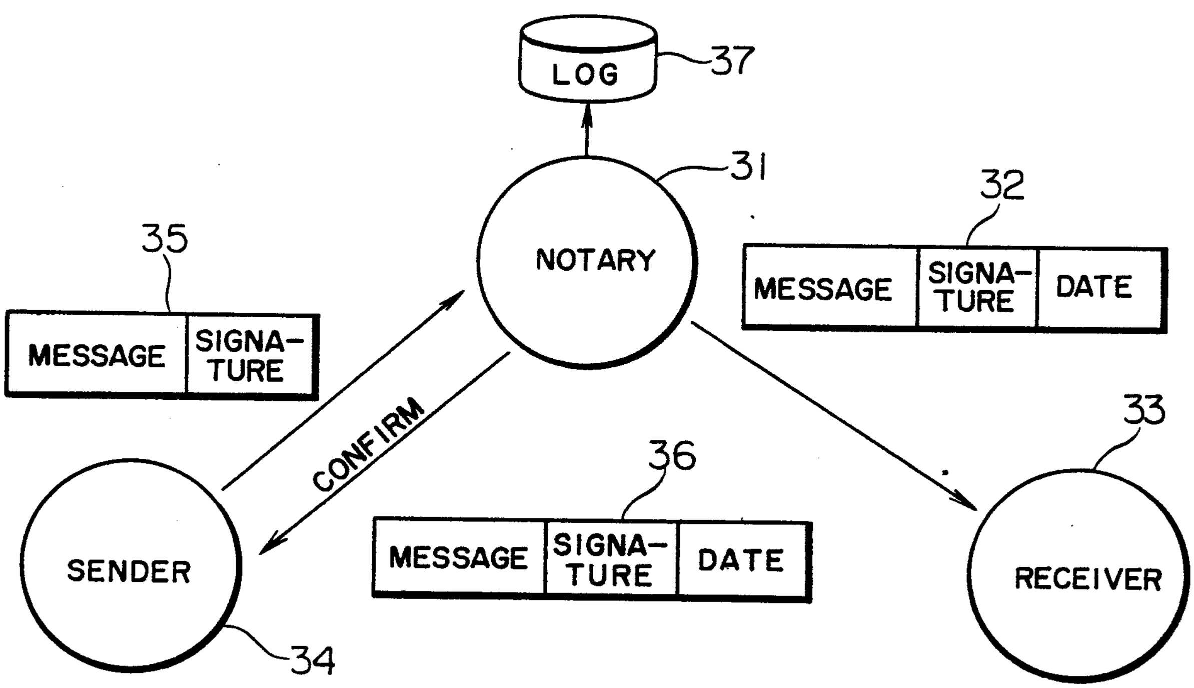


FIG. 2B PRIOR ART

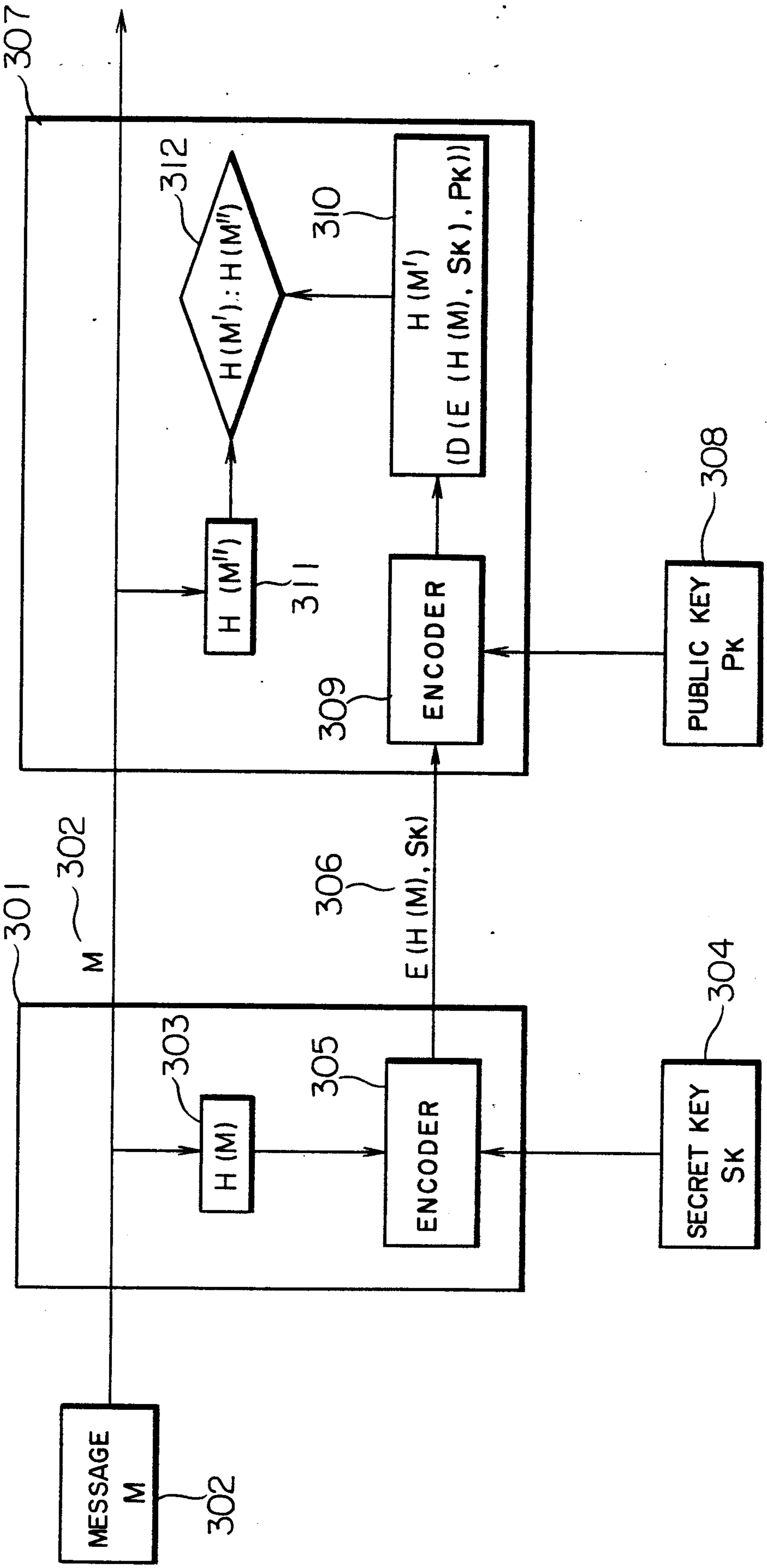


FIG. 4 PRIOR ART

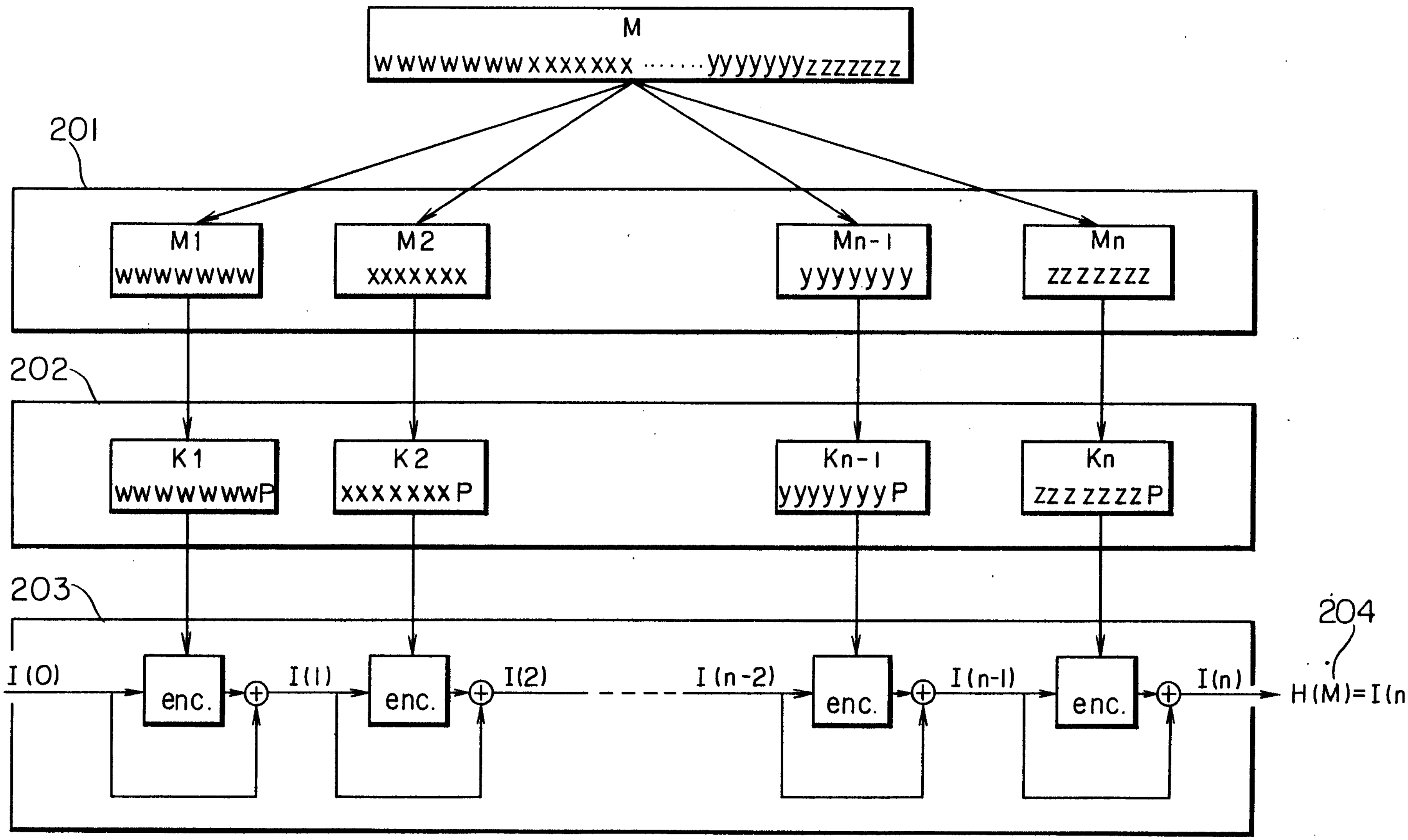


FIG. 5

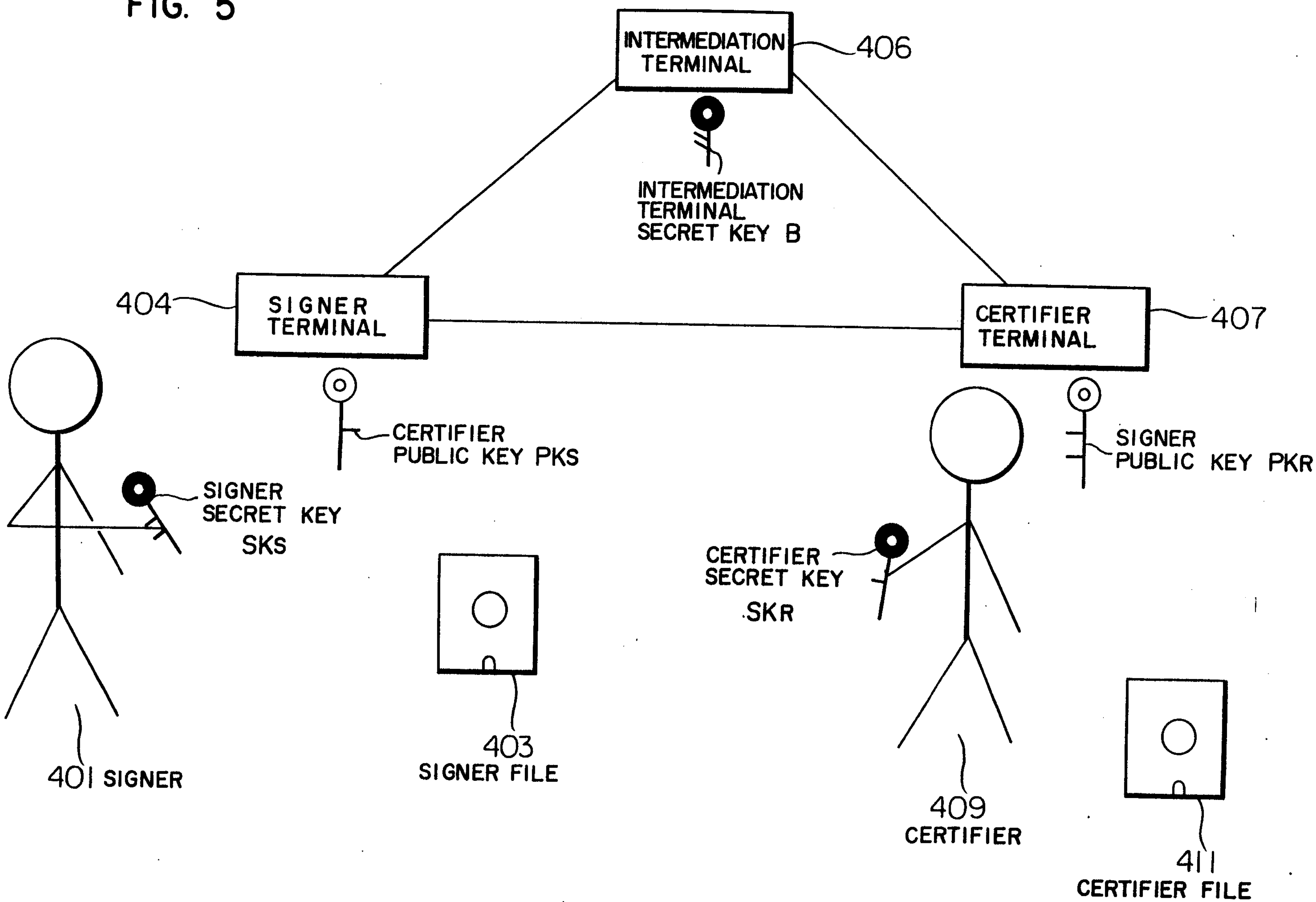

INTERMEDIATION TERMINAL
406
INTERMEDIATION TERMINAL SECRET KEY B
404
SIGNER TERMINAL
CERTIFIER TERMINAL
407
CERTIFIER PUBLIC KEY PKS
SIGNER PUBLIC KEY PKR
SIGNER SECRET KEY SKS
CERTIFIER SECRET KEY SKR
401 SIGNER
403 SIGNER FILE
409 CERTIFIER
411 CERTIFIER FILE

FIG. 6

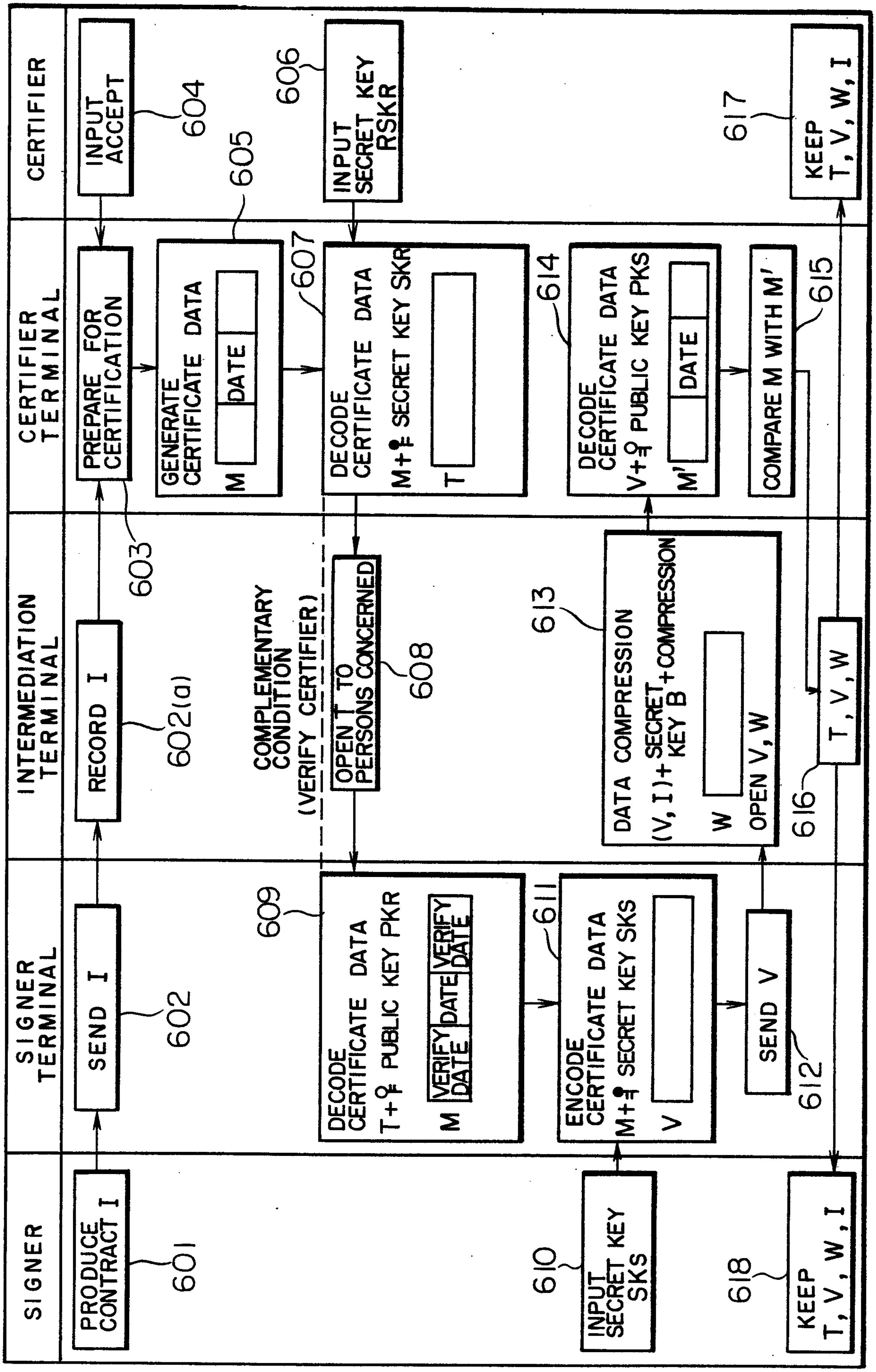

SIGNER
SIGNER TERMINAL
INTERMEDIATION TERMINAL
CERTIFIER TERMINAL
CERTIFIER
PRODUCE CONTRACT I
601
SEND I
602
RECORD I
602(a)
PREPARE FOR CERTIFICATION
603
INPUT ACCEPT
604
GENERATE CERTIFICATE DATA
M
DATE
605
INPUT SECRET KEY RSKR
606
DECODE CERTIFICATE DATA
M+ SECRET KEY SKR
T
607
COMPLEMENTARY CONDITION (VERIFY CERTIFIER)
OPEN T TO PERSONS CONCERNED
608
DECODE CERTIFICATE DATA
T+ PUBLIC KEY PKR
M
VERIFY DATE
DATE
VERIFY DATE
609
INPUT SECRET KEY SKs
610
ENCODE CERTIFICATE DATA
M+ SECRET KEY SKS
V
611
SEND V
612
DATA COMPRESSION
(V, I)+ SECRET KEY B +COMPRESSION
W
OPEN V, W
613
DECODE CERTIFICATE DATA
V+ PUBLIC KEY PKS
M'
DATE
614
COMPARE M WITH M'
615
T, V, W
616
KEEP T, V, W, I
617
KEEP T, V, W, I
618

FIG. 7

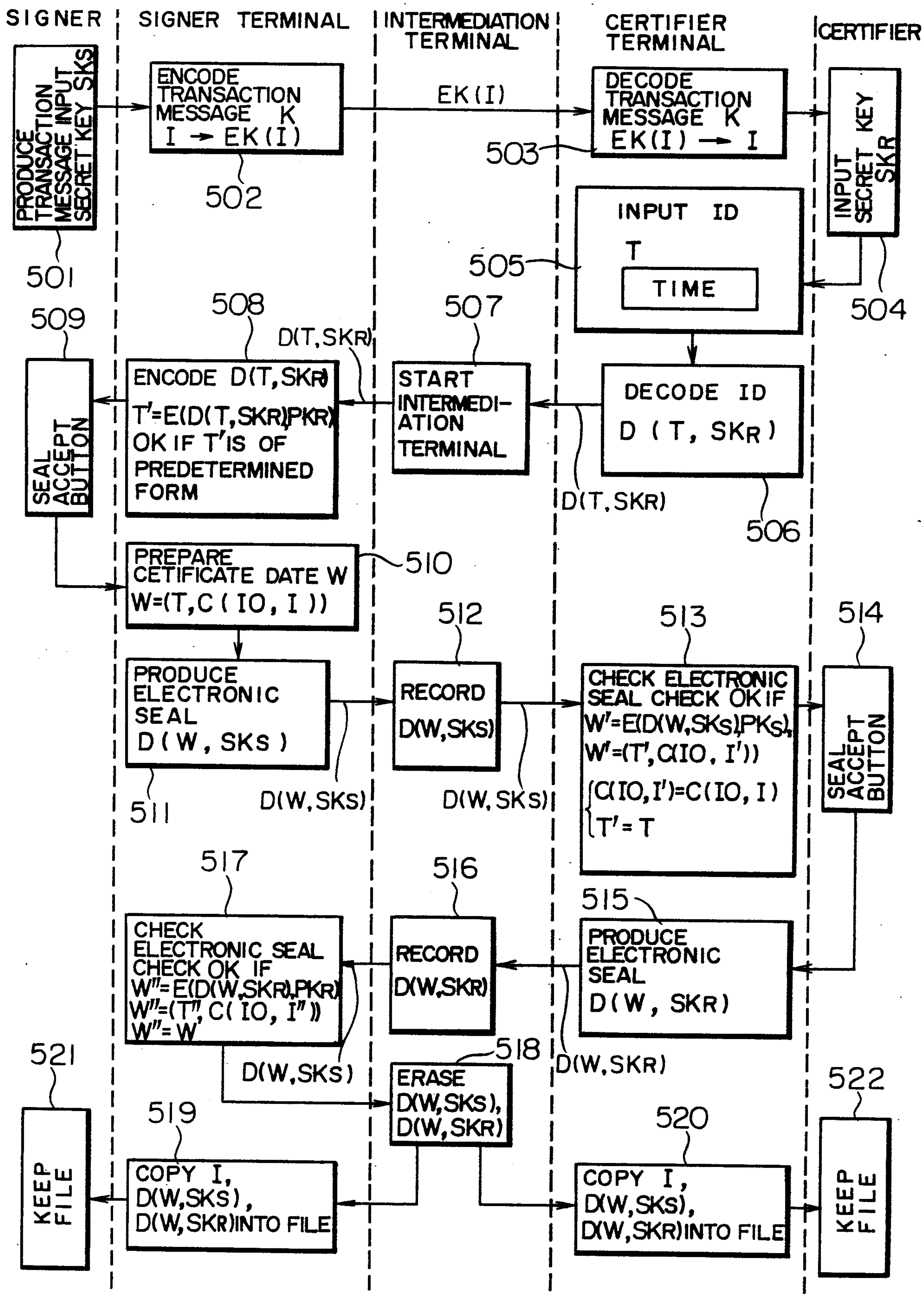
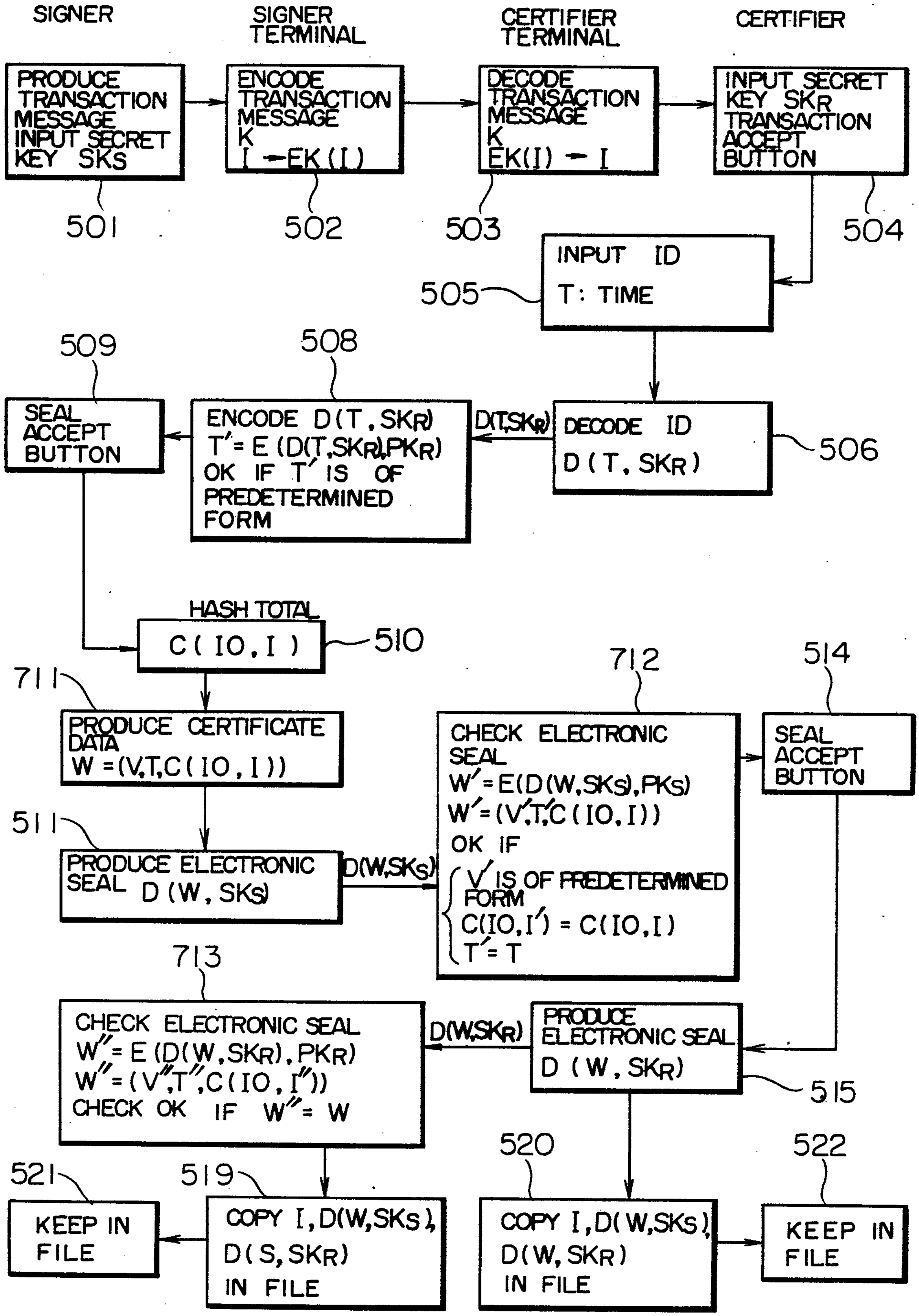
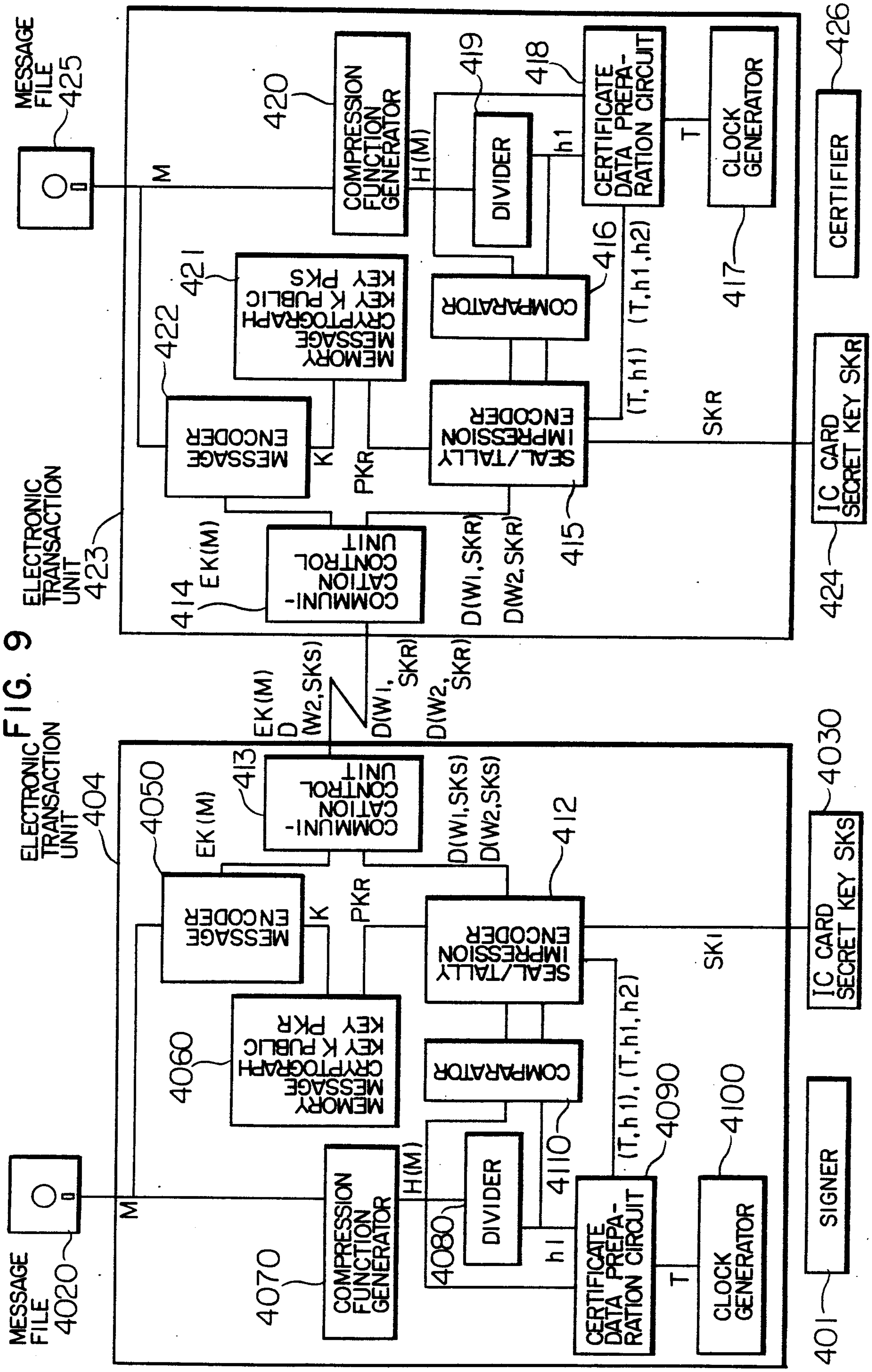

SIGNER
SIGNER TERMINAL
INTERMEDIATION TERMINAL
CERTIFIER TERMINAL
CERTIFIER
PRODUCE TRANSACTION MESSAGE INPUT SECRET KEY SKS
501
ENCODE TRANSACTION MESSAGE K
I → EK(I)
502
EK(I)
DECODE TRANSACTION MESSAGE K
EK(I) → I
503
INPUT SECRET KEY SKR
504
INPUT ID
T
TIME
505
509
508
D(T,SKR)
507
SEAL ACCEPT BUTTON
ENCODE D(T,SKR)
T'=E(D(T,SKR),PKR)
OK IF T' IS OF PREDETERMINED FORM
START INTERMEDIATION TERMINAL
DECODE ID
D(T, SKR)
D(T,SKR)
506
PREPARE CETIFICATE DATE W
W=(T,C(IO,I))
510
512
513
514
PRODUCE ELECTRONIC SEAL
D(W,SKS)
RECORD
D(W,SKS)
CHECK ELECTRONIC SEAL CHECK OK IF
W'=E(D(W,SKS),PKS),
W'=(T',C(IO,I'))
C(IO,I')=C(IO,I)
T'=T
SEAL ACCEPT BUTTON
511
D(W,SKS)
D(W,SKS)
517
516
515
CHECK ELECTRONIC SEAL CHECK OK IF
W''=E(D(W,SKR),PKR)
W''=(T'',C(IO,I''))
W''=W
RECORD
D(W,SKR)
PRODUCE ELECTRONIC SEAL
D(W,SKR)
521
D(W,SKS)
518
ERASE
D(W,SKS),
D(W,SKR)
D(W,SKR)
522
519
520
KEEP FILE
COPY I,
D(W,SKS),
D(W,SKR) INTO FILE
COPY I,
D(W,SKS),
D(W,SKR) INTO FILE
KEEP FILE

FIG. 8



SIGNER
SIGNER TERMINAL
CERTIFIER TERMINAL
CERTIFIER
PRODUCE TRANSACTION MESSAGE INPUT SECRET KEY SKS
ENCODE TRANSACTION MESSAGE K I → EK(I)
DECODE TRANSACTION MESSAGE K EK(I) → I
INPUT SECRET KEY SKR TRANSACTION ACCEPT BUTTON
501
502
503
504
INPUT ID
T: TIME
505
509
508
SEAL ACCEPT BUTTON
ENCODE D(T, SKR)
T′ = E (D(T,SKR),PKR)
OK IF T′ IS OF PREDETERMINED FORM
D(T,SKR)
DECODE ID
D (T, SKR)
506
HASH TOTAL
C(IO, I)
510
711
712
514
PRODUCE CERTIFICATE DATA
W = (V,T,C(IO, I))
CHECK ELECTRONIC SEAL
W′ = E(D(W,SKS),PKS)
W′ = (V′,T′,C(IO, I′))
OK IF
V′ IS OF PREDETERMINED FORM
C(IO,I′) = C(IO,I)
T′ = T
SEAL ACCEPT BUTTON
511
PRODUCE ELECTRONIC SEAL D (W, SKS)
D(W,SKS)
713
CHECK ELECTRONIC SEAL
W″ = E (D(W,SKR), PKR)
W″ = (V″,T″,C(IO, I″))
CHECK OK IF W″ = W
D(W,SKR)
PRODUCE ELECTRONIC SEAL
D (W, SKR)
515
521
519
520
522
KEEP IN FILE
COPY I, D(W,SKS), D(S,SKR) IN FILE
COPY I, D(W,SKS), D(W,SKR) IN FILE
KEEP IN FILE

FIG. 9


MESSAGE FILE 425
M
ELECTRONIC TRANSACTION UNIT 423
COMPRESSION FUNCTION GENERATOR
420
H(M)
DIVIDER
419
h1
418
CERTIFICATE DATA PREPARATION CIRCUIT
T
CLOCK GENERATOR
417
426
CERTIFIER
MEMORY MESSAGE CRYPTOGRAPH KEY K PUBLIC KEY PKS
421
422
MESSAGE ENCODER
K
PKR
COMPARATOR
416
(T, h1)
(T, h1, h2)
SEAL/TALLY IMPRESSION ENCODER
SKR
415
IC CARD SECRET KEY SKR
424
COMMUNICATION CONTROL UNIT
414
EK(M)
D(W1,SKR)
D(W2,SKR)
EK(M) D (W2,SKS)
D(W1, SKR)
D(W2, SKR)
ELECTRONIC TRANSACTION UNIT 404
4050
413
COMMUNICATION CONTROL UNIT
EK(M)
D(W1,SKS)
D(W2,SKS)
412
MESSAGE ENCODER
K
PKR
SEAL/TALLY IMPRESSION ENCODER
SKI
IC CARD SECRET KEY SKS
4030
4060
MEMORY MESSAGE CRYPTOGRAPH KEY K PUBLIC KEY PKR
COMPARATOR
(T,h1), (T,h1,h2)
4090
4110
4100
MESSAGE FILE 4020
M
COMPRESSION FUNCTION GENERATOR
4070
H(M)
DIVIDER
4080
h1
CERTIFICATE DATA PREPARATION CIRCUIT
T
CLOCK GENERATOR
SIGNER
401

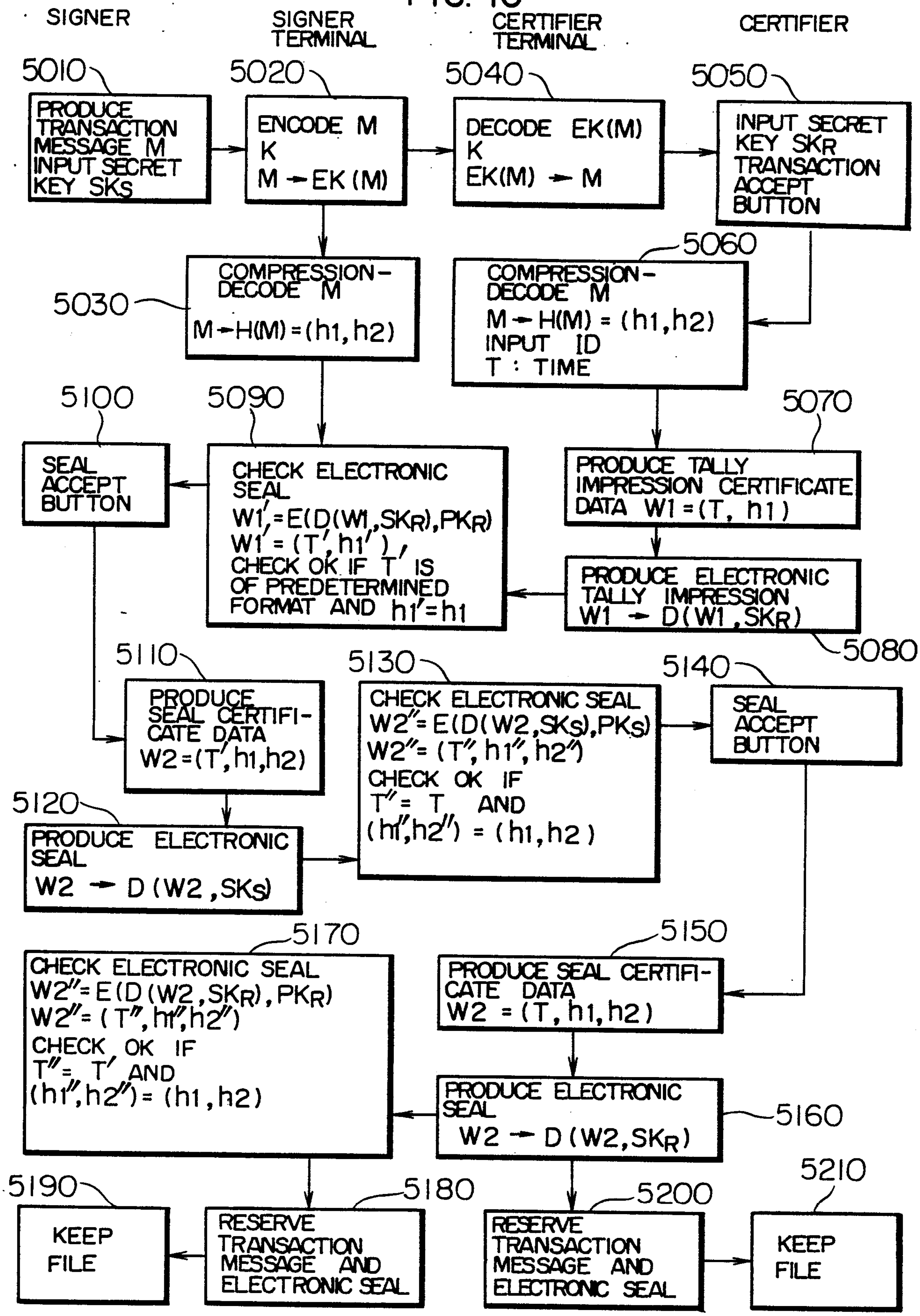

SIGNER
SIGNER TERMINAL
CERTIFIER TERMINAL
CERTIFIER
5010
PRODUCE TRANSACTION MESSAGE M INPUT SECRET KEY SKs
5020
ENCODE M K M → EK (M)
5040
DECODE EK(M) K EK(M) → M
5050
INPUT SECRET KEY SKR TRANSACTION ACCEPT BUTTON
5030
COMPRESSION-DECODE M M → H(M) = (h1, h2)
5060
COMPRESSION-DECODE M M → H(M) = (h1, h2) INPUT ID T : TIME
5100
SEAL ACCEPT BUTTON
5090
CHECK ELECTRONIC SEAL W1' = E(D(W1, SKR), PKR) W1' = (T', h1'), CHECK OK IF T' IS OF PREDETERMINED FORMAT AND h1' = h1
5070
PRODUCE TALLY IMPRESSION CERTIFICATE DATA W1 = (T, h1)
5080
PRODUCE ELECTRONIC TALLY IMPRESSION W1 → D(W1, SKR)
5110
PRODUCE SEAL CERTIFICATE DATA W2 = (T', h1, h2)
5130
CHECK ELECTRONIC SEAL W2'' = E(D(W2, SKs), PKs) W2'' = (T'', h1'', h2'') CHECK OK IF T'' = T AND (h1'', h2'') = (h1, h2)
5140
SEAL ACCEPT BUTTON
5120
PRODUCE ELECTRONIC SEAL W2 → D (W2, SKs)
5170
CHECK ELECTRONIC SEAL W2'' = E(D(W2, SKR), PKR) W2'' = (T'', h1'', h2'') CHECK OK IF T'' = T' AND (h1'', h2'') = (h1, h2)
5150
PRODUCE SEAL CERTIFICATE DATA W2 = (T, h1, h2)
5160
PRODUCE ELECTRONIC SEAL W2 → D (W2, SKR)
5190
KEEP FILE
5180
RESERVE TRANSACTION MESSAGE AND ELECTRONIC SEAL
5200
RESERVE TRANSACTION MESSAGE AND ELECTRONIC SEAL
5210
KEEP FILE

FIG. 10

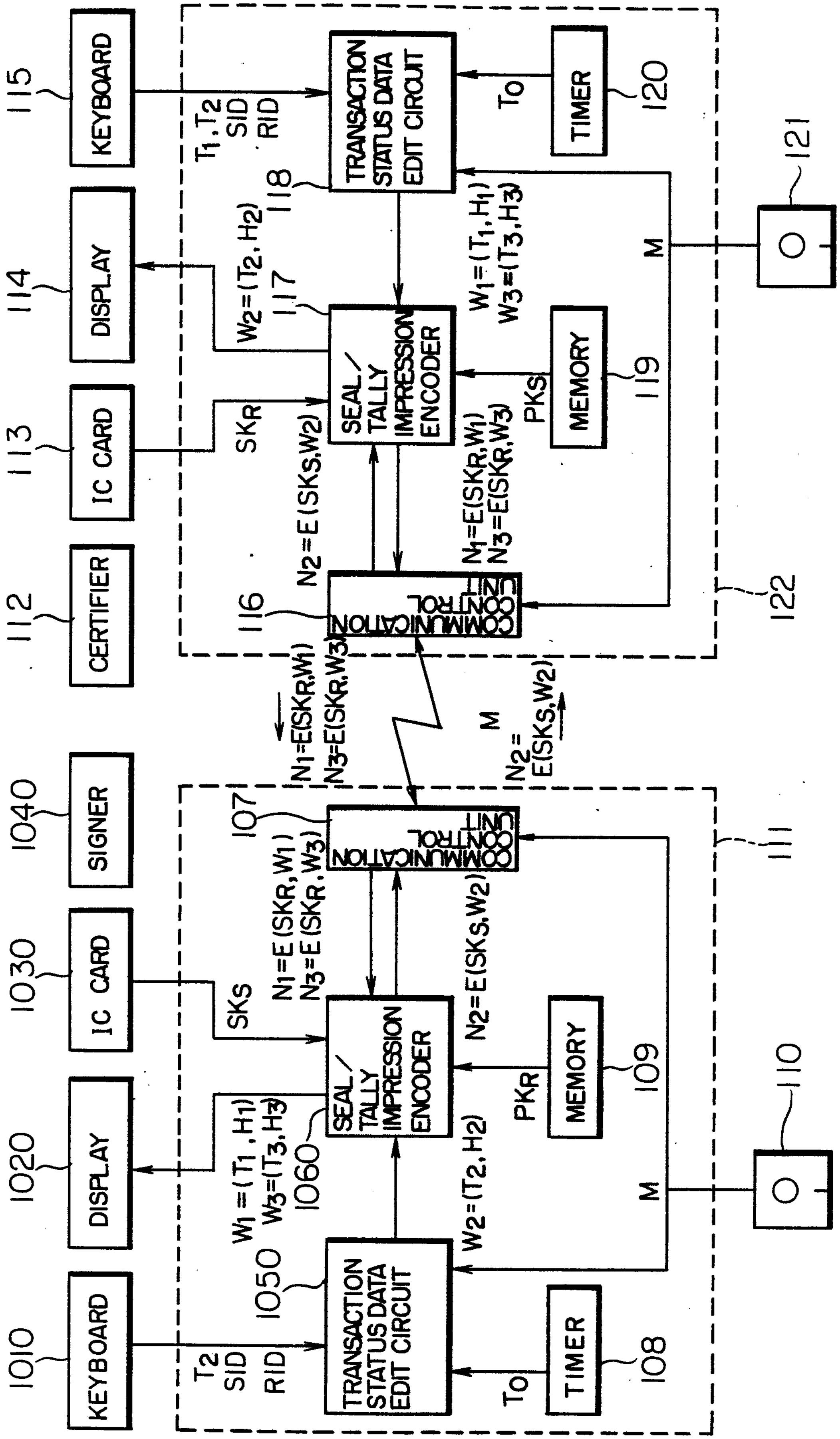
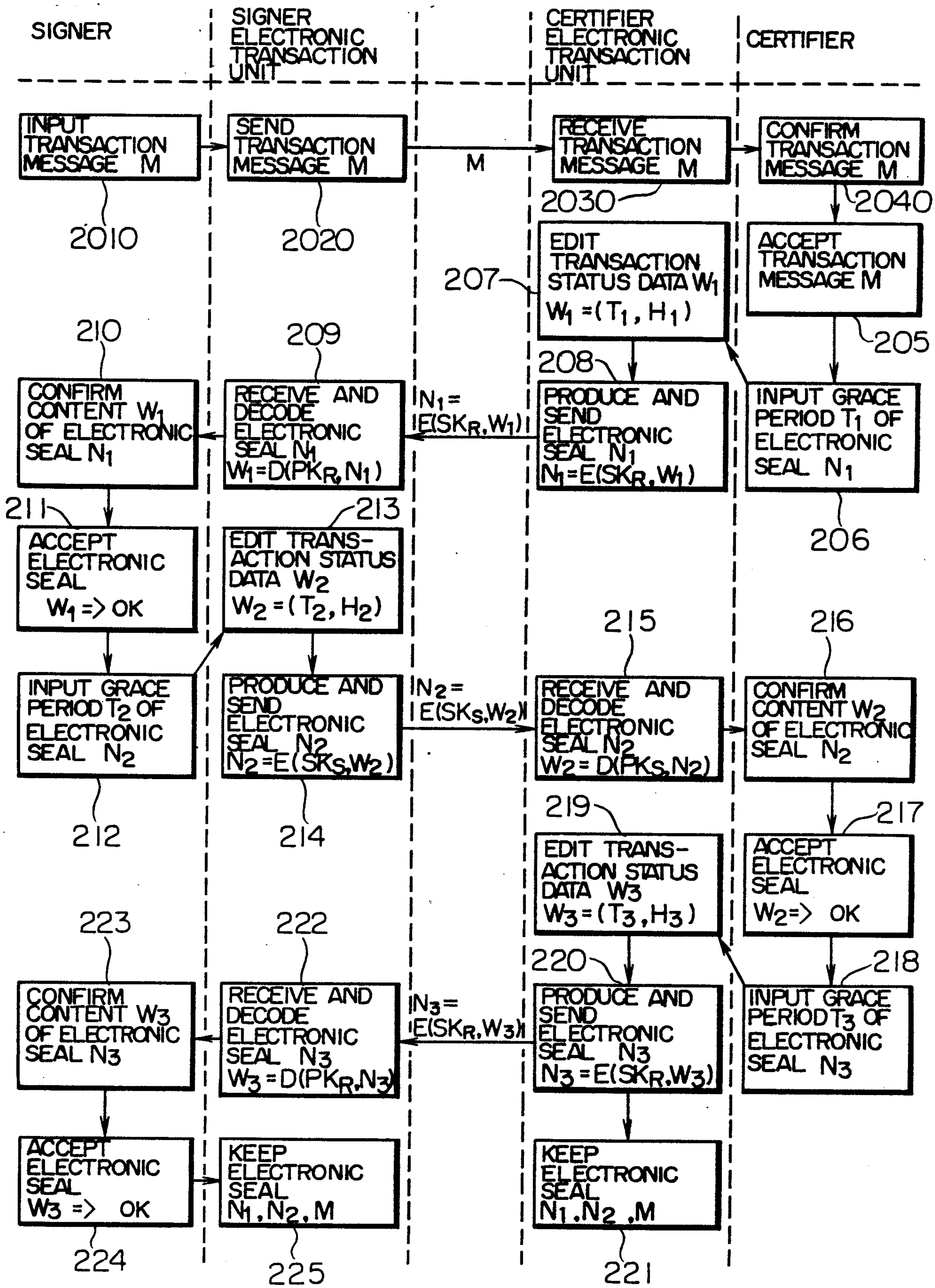

KEYBOARD
115
DISPLAY
114
IC CARD
113
CERTIFIER
112
T1,T2
SID
RID
TRANSACTION STATUS DATA EDIT CIRCUIT
118
To
TIMER
120
W2=(T2,H2)
117
SEAL/TALLY IMPRESSION ENCODER
SKR
PKS
MEMORY
119
W1=(T1,H1)
W3=(T3,H3)
M
121
N2=E(SKS,W2)
N1=E(SKR,W1)
N3=E(SKR,W3)
COMMUNICATION CONTROL UNIT
116
122
N1=E(SKR,W1)
N3=E(SKR,W3)
M
N2=E(SKS,W2)
SIGNER
1040
IC CARD
1030
DISPLAY
1020
KEYBOARD
1010
COMMUNICATION CONTROL UNIT
107
111
N1=E(SKR,W1)
N3=E(SKR,W3)
N2=E(SKS,W2)
SKS
SEAL/TALLY IMPRESSION ENCODER
1060
PKR
MEMORY
109
W1=(T1,H1)
W3=(T3,H3)
W2=(T2,H2)
M
110
TRANSACTION STATUS DATA EDIT CIRCUIT
1050
T2
SID
RID
To
TIMER
108

FIG. 11

FIG. 12



SIGNER
SIGNER ELECTRONIC TRANSACTION UNIT
CERTIFIER ELECTRONIC TRANSACTION UNIT
CERTIFIER
INPUT TRANSACTION MESSAGE M
2010
SEND TRANSACTION MESSAGE M
2020
M
RECEIVE TRANSACTION MESSAGE M
2030
CONFIRM TRANSACTION MESSAGE M
2040
EDIT TRANSACTION STATUS DATA W1
W1 =(T1, H1)
207
ACCEPT TRANSACTION MESSAGE M
205
210
CONFIRM CONTENT W1 OF ELECTRONIC SEAL N1
209
RECEIVE AND DECODE ELECTRONIC SEAL N1
W1=D(PKR,N1)
N1= E(SKR,W1)
208
PRODUCE AND SEND ELECTRONIC SEAL N1
N1=E(SKR,W1)
INPUT GRACE PERIOD T1 OF ELECTRONIC SEAL N1
206
211
ACCEPT ELECTRONIC SEAL
W1 => OK
213
EDIT TRANS-ACTION STATUS DATA W2
W2 =(T2, H2)
215
216
INPUT GRACE PERIOD T2 OF ELECTRONIC SEAL N2
212
PRODUCE AND SEND ELECTRONIC SEAL N2
N2=E(SKS,W2)
214
N2= E(SKS,W2)
RECEIVE AND DECODE ELECTRONIC SEAL N2
W2= D(PKS,N2)
CONFIRM CONTENT W2 OF ELECTRONIC SEAL N2
219
EDIT TRANS-ACTION STATUS DATA W3
W3=(T3,H3)
217
ACCEPT ELECTRONIC SEAL
W2=> OK
223
222
220
218
CONFIRM CONTENT W3 OF ELECTRONIC SEAL N3
RECEIVE AND DECODE ELECTRONIC SEAL N3
W3=D(PKR,N3)
N3= E(SKR,W3)
PRODUCE AND SEND ELECTRONIC SEAL N3
N3=E(SKR,W3)
INPUT GRACE PERIOD T3 OF ELECTRONIC SEAL N3
ACCEPT ELECTRONIC SEAL
W3 => OK
224
KEEP ELECTRONIC SEAL
N1, N2, M
225
KEEP ELECTRONIC SEAL
N1, N2, M
221